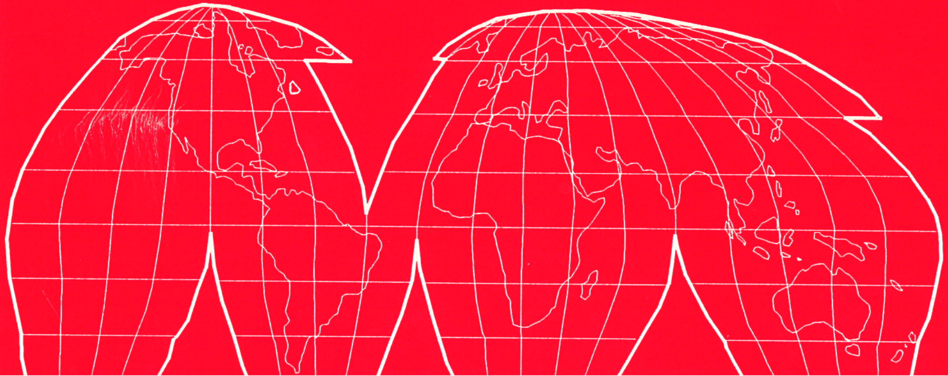
Nordberg®

A Nordberg Group Company

Reference Manual

Fourth Edition



Nordberg Inc.

Reference Manual

The information contained in this booklet is intended for estimating purposes only. Due to the many variables in rock conditions, the individual attributes of plant operations and the many physical variations involved, neither Nordberg Inc. nor its representatives warrant expressly or implicitly that the described machines will perform as estimated.

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PREFACE

This reference manual is intended as an aid which, when coupled with experience and good knowledge of prevailing local conditions can assist in estimating true system performance. In estimating process machinery system performance all factors must be considered; not only productivity and costs but also safety, serviceability, parts availability and application assistance, just to mention a few.

The data is based on extensive field testing, computer analysis, laboratory research and continued growth in experience with process machinery. Every effort has been made to assure correctness.

Most data is based upon the achievement of 100% efficiency in operation - a status which cannot be achieved continuously even under ideal conditions. Thus, in using such performance and production data, it is necessary to correct the results indicated in the tables by appropriate factors to allow for the anticipated actual job efficiency, operator efficiency, material characteristics, altitude and other factors which may influence performance or production on a particular job.

Nordberg Inc. has made every effort to insure that the information contained in this manual is accurate and is a fair statement of the results to be achieved under the circumstances indicated. However, because of the many variables involved in estimating the production or performance of process machinery wear rates, methods of feeding, repair costs, and the possibility of inadvertent errors or omissions in assembling this data, Nordberg cannot and does not imply that all data in this book is complete nor that this level of performance will be achieved on a given job.

Specifications shown in this Reference Manual were current at the time of printing. However, do to Nordberg Inc.'s many machine improvement programs, specifications and materials may change without notice. For current specifications relating to a machine, please consult Nordberg or its authorized representatives for certified installation drawings.

Specifications and information in this manual relate to Nordberg and Symons equipment manufactured for or by Nordberg Group facilities throughout the world unless otherwise specifically identified.

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Safety

INTRODUCTION

This section of the Nordberg Reference Manual has been composed for Nordberg Inc. Personnel. It outlines basic safety procedures that can help to prevent employee injury and equipment damage. This section illustrates only basic safety procedures, additional precautions may be necessary for the safe operation of Nordberg products described in other sections of this manual. The information contained here has not been compiled to replace any safety codes, insurance requirements, Federal, State and Local laws or company rules and regulations.

PERSONNEL SAFETY

Safety should always be a major concern of equipment operators and maintenance personnel. It is the responsibility of the operator to know what specific requirements, precautions and work area hazards exist to assure safe equipment operation. It is the responsibility of maintenance personnel to understand what hazards exist before any maintenance work is performed. Additionally, maintenance personnel should always exercise complete safety precautions while servicing equipment.

SAFETY TIPS FOR EQUIPMENT OPERATORS

Stop Accidents Before They Stop You

Even the safest equipment should be operated with care and complete knowledge of machine performance capabilities. Remember you are the key to safety. By practicing good safety precautions, you protect yourself and the people in your work area. Safety records show that the greatest percentage of accidents occur when an employee simply disregards safety rules. Familiarize yourself with your company's safety program and insist that your fellow workers abide by safety rules and regulations. Do not consume alcoholic beverages before coming to work or while on the job. Beware of medicines, tranquilizers or other drugs which can make you sleepy or less alert. By practicing safety you prevent accidents from happening.

Dress Properly

Find out what safety items are required before you operate a piece of machinery. You may need any number of special items – safety hat, safety shoes, safety glasses, goggles, heavy gloves, ear protective devices, etc. Exercise safety measures by wearing all required safety items.

Loose clothing can catch in moving parts. Keep sleeves buttoned and jackets belted. Wear clothing that will keep you warm without restricting your movement. Wrist watches and rings should be removed to prevent possible injury. Keep your pockets free of objects that may fall out.

Understand Your Machinery

Before you begin operation, read the operator's manual furnished with your specific equipment. Learn equipment operation and maintenance procedures; capacities and limitations. Understand the location and function of the controls, indicators, warning devices and caution instructions. Be alert to conditions such as low pressure or high temperature that may create a hazardous situation during operation.

Know Your Work Area And Keep It Clean

Learn as much as possible about the

limitations of your work area. Know the weight limitations for any floors on which your equipment is located. Find out what the clearances are in the work area. A little time spent checking side and overhead clearances, including power lines, can save a lot of trouble later.
Be a good housekeeper. Keep the floor clean and free of oil, grease, rags, cables, chains, buckets, rocks and other hazardous items. Keep loose parts or tools in a safe place. Be careful of dust, smoke or fog that may obscure your vision. Use only nonflammable solutions when cleaning equipment.

Always Be Prepared For Emergencies
Plan Ahead — Stay Alert — Operate Sensibly and you will avoid personal injury and accidental equipment damage. If an accident does happen — react quickly with the tools at hand. Know the location of fire extinguishes and first aid kits and how to use them. Know where to get prompt assistance — an emergency calls for fast action.

Examine Equipment Before Start-Up
Equipment not properly prepared for operation is unsafe equipment. Run a thorough check at the beginning of your shift. Don't think twice — if you find something that needs attention. Report any equipment defects to your supervisor. The following is a brief checklist to follow prior to equipment start-up.

1. Make sure all guards and other protective devices are in place secure and not damaged.
2. Check hydraulic fluid circuits and accumulator gas enclosures. Are they at their correct levels, correct pressure and completely leak-free? Loss of hydraulic pressure due to low fluid levels can lead to serious equipment failures.
3. Check every drain cock, valve, and fittings to be sure they are in place and secure.
4. Never adjust pressure relief valves to get higher operating pressures. The manufacturer's recommended pressures give the safest performance with the longest usage.
5. Never tamper with equipment safety devices.
6. Check the equipment thoroughly for visual defects such as leaks, worn hoses or belts, or loose parts.
7. Inspect your machine in accordance with the instructions contained in your operators manual.
8. Before start-up walk completely around your machine. Make sure there is no one next to, under; or on the machine. Warn any personnel nearby that you are starting up.
9. Check equipment for warning tags.

Start-Up Safety
1. Follow the recommended start-up procedures outlined in the operation section of your instruction manual.
2. After the machine has been started check all gauges and instruments to insure that everything is operating properly.
3. Shut down the machine immediately if any improper readings are observed.
4. Test all controls for proper functioning.
5. Listen for and report any unusual noises.
6. Recheck alarms and other warning and safety devices.

Stop Operation Safely
Make sure your machine has completely stopped before . . . cleaning, servicing, lubricating, checking belt tension, removing housing covers, working on the hydraulic system or making repairs. Do not attempt to service your equipment while it is in operation.

SAFETY TIPS FOR MAINTENANCE PERSONNEL

Read And Understand . . .

1. The instruction manual furnished with your machinery, especially the section on OPERATION.
2. Instructions for inspection and maintenance located at the rear of your manual.
3. Warning and caution plates located on the machine.
4. Warning and caution notes in the instruction manual.
5. Lubrication and Maintenance guides for periodic servicing.

Use Warning Tags

Before working on any equipment, attach warning tags directly to the machine near the controls.

Use warning tags:

1. If the machine is unsafe for operation.
2. If controls are being serviced.
3. If the machine is being repaired.

Lockout The Electrical Service

1. Always lockout all electrical controls before performing any type of maintenance work.
2. When servicing a hydraulic power unit lockout the electrical service to the power unit. NOTE: Depressing the "STOP" button will only stop the motor.
3. Always have your own personal padlock and ONE key easily accessible.

Dress Properly

1. Keep hands and clothing away from moving parts. Do not take chances by wearing loose sleeves, floppy ties, watches and rings.
2. Wear eye protection when handling fuel, cleaning fluid, oil or brake fluid. These materials can damage your eyes.
3. Wear a respirator when required.
4. Wear safety glasses when drilling, grinding or hammering metal.
5. Keep your pockets free of objects which can fall out and into machinery.
6. Wear a hard hat and safety shoes when required.
7. Wear gloves to protect your hands when changing cables.
8. Wear safety glasses and protective clothing when using high pressure air.
9. Wear safety goggles and protective clothing when handling molten metals; zinc, babbitt, lead, etc.
10. Wear ear protective devices when required or reduce exposure time as required.

Alcoholic Beverages And Medication

1. Do NOT consume alcoholic beverages before coming to work or while on the job.
2. Beware of medicines, tranquilizers or other drugs which can make you sleepy or less alert.

Keep Your Work Area Clean

1. Promote good housekeeping, keep the floor clean and dry, free of debris and tools. Oily and wet floors, steps and hand rails are slippery. In winter watch out for ice and snow. Wet spots, especially near electrical equipment are dangerous.
2. Do NOT let material lay and build up on or around the equipment.
3. Store dangerous fluids in a suitable place — away from unauthorized personnel. Allow no smoking in the area!
4. Never start a diesel or gasoline engine within an enclosed area unless there is adequate ventilation. Exhaust fumes can kill.

Perform Maintenance Work Safely

1. Use the proper tools; handle tools and heavy parts sensibly.
2. Keep all tools and equipment free of dirt oil and grease. Do not drop or toss them.
3. Use hoisting equipment for heavy lifting.
4. Lower parts, do not drop them.

5. To prevent slipping, wipe hand levers and knobs clean of oil or grease.
6. Do not use sheaves with cracked rims or spokes.
7. Check for missing, cracked or frayed V-belts before you operate equipment.
8. Check for broken, defective or missing parts and replace them. Keep equipment clean and free of dirt and oil so you can spot loose or defective parts.
9. When using cables to move a load, be sure cables are of adequate size and replace any worn, badly frayed, broken or kinked ones. Check end connections for wear.

Be Aware Of Fire Hazards

1. Do NOT smoke while refueling — or when handling fuel containers.
2. Shut off your engine when refueling — and use extra caution if engine is hot.
3. When pouring fuel into the tank, ground the funnel or spout against the filler neck to avoid static electric spark.
4. Do NOT use gasoline or diesel fuel for cleaning parts. Good commercial, nonflammable solvents are safer.
5. Do NOT smoke while using cleaning solvents.
6. Do NOT let greasy, oily rags accumulate in a poorly ventilated area. Store oily rags and other combustible material in a safe place.
7. Never use an open flame to check fuel, battery electrolyte or coolant levels . . . or to look for hydraulic leaks anywhere on the equipment. Use a flashlight!
8. Know where fire extinguishers are kept - and how they operate — and for what type of fire. Check regularly — at least monthly — to be sure they are in good working condition.

Examine Pressurized Systems — Hydraulic Or Air — Carefully

1. Relieve all pressure before opening or removing any hydraulic or gas pressure lines, valves, fittings, containers, etc.
2. Check for worn hoses or damaged lines.
3. High pressure oil can be dangerous.

Use Quality Parts

A replacement part for any item should always be of comparable size, type and quality — as the part being discarded.

Report Necessary Repairs

If your daily check uncovers any item that needs repair, replacement or adjustment — report it immediately. The most minor defect could result in more serious trouble — if the machine is operated.

Only perform the work you're authorized to do. Do not attempt repairs you do not understand.

Only work on equipment you thoroughly understand — a pressure-loaded part, if carelessly released, could injure anyone in its path.

Remember you are entrusted with the maintenance of a highly valuable piece of equipment. Treat it with care.

Plant Safety

The safety procedures mentioned here do not eliminate all safety hazards found in the area of crushing plants. However, they do highlight some of the procedures which have improved safety conditions around plants. Nordberg welcomes inquiries regarding other suggested safety procedures for use around our machinery.

Drive Guards

Proper safety precautions start with the initial installation of the machine. Crushers, for example are driven either by V-belts or by direct couplings to motors. The belt drive or coupling should have a protective guard around it.

Crusher sheaves in particular are designed for maximum rim speeds. If these speeds are exceeded it is possible that the sheave could explode and cause severe injury or even death.

1-5 SAFETY

Maintenance Platform
Periodic inspection and maintenance must be performed on each machine and it is important that some type of platform be erected at a level convenient for the maintenance men who must inspect and work on the machine. A good platform constructed of "solid" floor plate should have hand railings, toe plates and wire mesh or expanded metal between the platform and the top of the hand railing to prevent tools from dropping off the platform and hitting someone working below. Do not fasten the platform directly to the machine.

Electrical Lockout
The electrical power source for any machine should be locked out whenever anyone is working on it. Each maintenance man who normally works on the machine should be provided with his own personal padlock with only one key. When he works on any assembly he should use the padlock to lock out the electrical controls. It is most important that only one key be provided for the lock and that key must be in the pocket of the person who is performing the repair work. If more than one person works on the machine, each should have his own lock and key at separate lockout stations for the machine controls. Accidental start-up of equipment with men in the immediate area can cause an accident on what was supposedly a "clear" machine.

Cranes
One of the most flagrant safety violations is the use of inadequate and unsafe lifting equipment. When using a crane always operate within the rated capacity of the crane. The safe rated capacity includes; weight of hook, block, and handling devices such as cables, slings, spreader bars, etc. Subtract the weight of all items from the rated capacity of the crane to find the true weight of the load that can be handled safely. Chain falls should be considered only as a last resort to assemble and disassemble a machine. When it comes to safety, the best should be used.

Mobile Cranes
When using a mobile crane, always operate within the rated capacity of the machine to avoid buckling the boom or tipping. Safe ratings are based on operating the crane on firm, level ground; outriggers should be properly extended and/or lowered whenever possible. Avoid fast swings, hoists or sudden braking; these can cause overloads. Do not handle large heavy loads in strong winds.

When moving your crane, check bridges before crossing, make sure they will support the weight of the machine. Check clearances under bridges, for overhead electrical lines or any overhead obstruction.

Check your hitcher, be sure he's clear before you start to lift. Make certain he securely attaches the load.

Welding Equipment
The cutting torch is one of the most frequently used tools for normal plant maintenance procedures. When a torch is used, hydraulic components should be depressurized and adequately covered with flameproof material so that sparks, weld spatter, etc., cannot reach these areas. Ruptured high pressure hydraulic lines will quickly vaporize the hydraulic fluid as it reaches the atmosphere. This vaporized fluid can quickly become a mass of flames, resulting in severe burns for personnel in the immediate area. All maintenance personnel who normally use torch cutting equipment should be advised if there are hydraulic components in the immediate area in which they are working. Then adequate precautions should be made to avoid contact with those components. Rubber lined hoses are not immune to the torch cutting equipment.

Conveyor Belts
Do NOT use conveyor belts as walkways. Conveyor belts leading to and from equipment should have walkways alongside. Always provide hand rails along the conveyor belt walkway as an added safety precaution.

Crushing Plant "Noise"
Crushing equipment by its very nature is

noisy, and the auxiliary equipment found in and around crushing equipment such as chutes, transfer stations, screens, etc., can at times be noisier than the crusher itself. Ear protective devices may be required if noise levels are higher than those allowed by law. If ear protective devices are undesirable, consideration should be given to reducing the amount of noise exposure that an operator or maintenance man may be subjected to, in other words, shorter working hours.

Although alteration of the machinery to change its noise characteristics may be economically impossible, many plants have found that the installation of a relatively inexpensive operator's station can improve noise conditions. The operator can see the equipment in operation and still be protected from the noise through the installation of acoustical tile, double windows, air conditioning equipment, etc. These working conditions will normally result in a more efficient operation and reduce potential injuries from noise.

Many plant operators are finding that an operator's tower erected at an elevation above most of the equipment provides both safety features for the operator and increased efficiency in plant operation.

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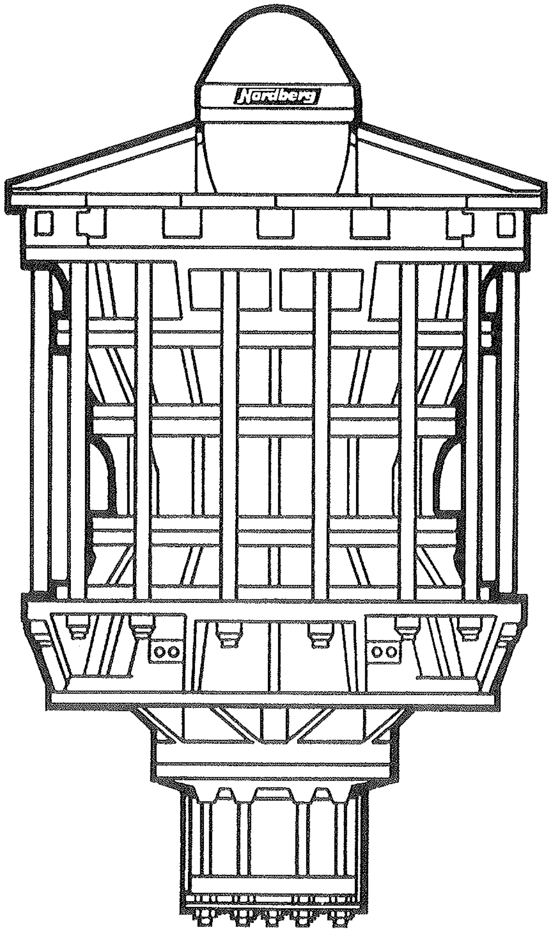
Gyratory Crushers



SECTION DATA

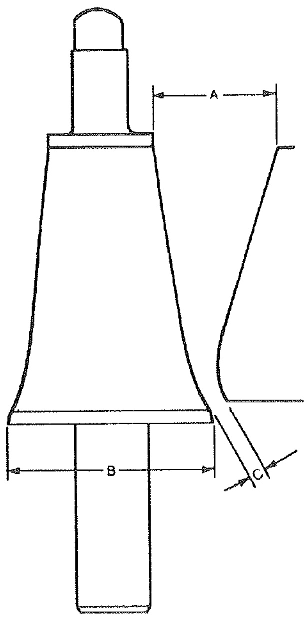
The condensed information on these pages is only a guide in determining the size and operating data of a Nordberg Primary Gyratory Crusher for a particular application. Crusher capacities in these tables are given in short tons (2000 lbs) per hour and are based on average operating conditions when handling a dry friable material weighing 100 lbs./cu. ft. (crushed). Factors which may affect capacity include hardness, toughness, fracture pattern, moisture content, size gradation of the feed material and method of feeding.

For specific or special recommendations the following information should be submitted to Nordberg for analysis.

- Type or nature of material to be crushed.
- Information pertaining to the material to be crushed: work index, compressive strength, bulk density, moisture content (Nordberg's Research and Mineral test center has facilities for determining the work index, if samples are available).
- Method of feeding: Direct dump, feeder scalping (Indicate capacity or rate of feeding unit).
- Size of largest rock in the feed.
- Approximate or average screen analysis of material to be fed to the crusher.
- Size of product required.
- Capacity desired (in tons per hour).

Application recommendations for settings smaller or larger than those listed in this section will be made by Nordberg upon receipt of full technical data.

The horsepower column represents the maximum design horsepower. These ratings do not refer to the horsepower required for capacities listed. In general the recommended size, type and capacity of the crusher can be determined from the information contained in this section. Horsepower for specific applications can be determined from the "FORMULA FOR HORSEPOWER DETERMINATION" chart. See Pages 2-6 through 2-13.



Example:
42-70 with a 6" O.S.S. (150mm)
A = 42" (1067mm)
B = 70" (1778mm)
C = 6" (150mm)

The countershaft RPM specified for each crusher has been selected for the most economical motor for a direct drive arrangement. When a V-belt drive is employed a relatively higher speed motor may be used with a corresponding saving in motor and drive costs. Recommendation of specific drives will be made by Nordberg on receipt of full information.

CAPACITIES OPERATING DATA -- SHORT TONS

CRUSHER SIZE A-B INCH	MAXIMUM DESIGN HORSEPOWER	CTR SHAFT RPM	GYRA PER MIN	ECC THROW INCH	OPEN SIDE DISCHARGE SETTING - C INCH												
					4	4-1/2	5	5-1/2	6	6-1/2	7	7-1/2	8	8-1/2	9	9-1/2	10
30-60	250	450	190	3/4	470	580	690	780									
				7/8	570	680	820	950									
				1	640	780	930	1050									
				1-1/4	800	970	1170	1290									
42-70	400	600	160	3/4		690	750	820	880	960	1030	1100					
				1		910	1010	1110	1210	1320	1430	1550					
				1-1/8			1130	1240	1370	1500	1630	1770					
				1-1/4				1360	1460	1720	1860	2000					
48-75	500	514	140	1-1/4			1230	1420	1540	1780	1970	2190	2430				
				1-3/8			1370	1500	1680	1920	2160	2410	2660				
				1-1/2				1620	1820	2080	2340	2600	2880				
				1-5/8				1700	1950	2230	2520	2810	3110				
54-75	500	514	140	1-1/4			1140	1330	1530	1750	1970	2190	2420				
				1-3/8			1240	1460	1670	1910	2140	2390	2640				
				1-1/2				1580	1830	2090	2350	2620	2900				
				1-5/8				1690	1960	2250	2550	2840	3160				
60-90	700	514	130	1-3/8					2130	2360	2590	2830	3060	3310	3570		
				1-1/2					2310	2560	2810	3060	3330	3610	3880		
				1-5/8					2480	2730	2990	3260	3530	3800	4090		
				1-3/4					2620	2940	3250	3570	3920	4260	4600		
60-110	1000	514	115	1-1/2							3480	3640	3810	3990	4160	4350	4530
				1-5/8							3740	3930	4130	4330	4530	4740	4960
				1-3/4							3990	4200	4430	4660	4890	5130	5380
				2							4510	4740	4970	5210	5450	5700	5960
72-112	1400	514	115	1-1/2							3050	3440	3820	4230	4630	5060	5480
				1-5/8							3300	3710	4130	4570	5020	5480	5940
				1-3/4							3500	3930	4360	4810	5260	5730	6210
				2							3920	4430	4930	5450	5980	6520	7080

Capacities given in these tables are instantaneous capacities in short tons (2000 lbs.) per hour.

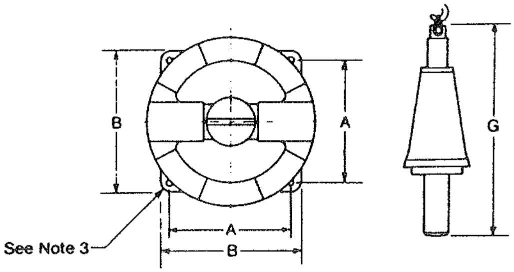
*Recommended motor to be wound rotor with 1.15 service factor and characteristics of 200% starting and 250% to 300% breakdown torque.

CAPACITIES OPERATING DATA -- METRIC TONS

CRUSHER SIZE A-B mm	MAXIMUM DESIGN HORSEPOWER*	CTR SHAFT RPM	GYRA PER MIN	ECC THROW mm	OPEN SIDE DISCHARGE SETTING - C millimeters												
					100	115	125	141	150	165	180	190	205	215	230	240	255
762-1524 (30-60)	250	450	190	19	426	526	626	707									
				22	517	617	744	862									
				25	580	707	843	952									
				32	726	880	1061	1170									
1067-1778 (42-70)	400	600	160	19		626	680	744	798	871	934	998					
				25		825	916	1007	1097	1197	1297	1406					
				29			1025	1125	1242	1360	1478	1605					
				32				1233	1324	1560	1687	1814					
1219-1905 (48-75)	500	514	140	32			1116	1288	1397	1614	1787	1986	2204				
				35			1242	1360	1524	1741	1959	2186	2413				
				38				1469	1651	1886	2122	2358	2612				
				41				1542	1769	2023	2286	2549	2821				
1372-1905 (54-75)	500	514	140	32			1034	1206	1388	1587	1787	1986	2195				
				35			1125	1325	1515	1732	1941	2168	2394				
				38				1433	1660	1896	2131	2376	2630				
				41				1534	1778	2041	2313	2575	2866				
1524-2286 (60-90)	700	514	130	35					1932	2140	2349	2567	2775	3002	3238		
				38					2095	2322	2549	2775	3020	3274	3519		
				41					2249	2476	2712	2957	3202	3447	3709		
				44					2376	2666	2948	3238	3555	3864	4172		
1524-2794 (60-110)	1000	514	115	38							3156	3301	3456	3619	3773	3945	4109
				41							3392	3564	3746	3927	4109	4299	4499
				44							3619	3809	4018	4297	4435	4653	4880
				51							4090	4299	4508	4725	4943	5170	5406
1829-2845 (72-112)	1400	514	115	38							2766	3120	3465	3837	4199	4589	4970
				41							2993	3365	3746	4145	4553	4970	5387
				44							3174	3564	3954	4363	4771	5197	5632
				51							3555	4018	4471	4943	5424	5914	6421

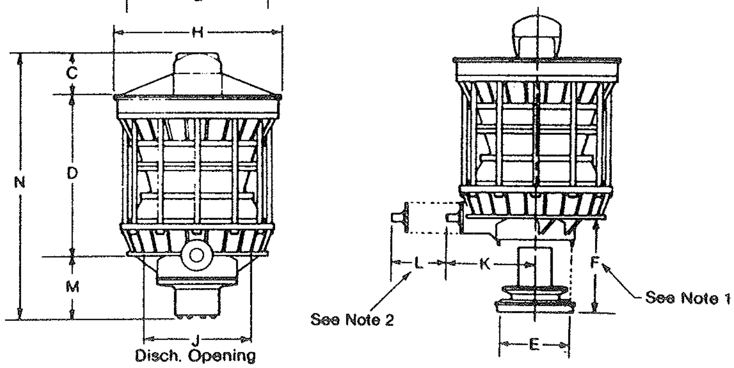
Capacities given in these tables are instantaneous capacities in metric tons (2200 lbs.) per hour.
*Recommended motor to be wound rotor with 1.15 service factor and characteristics of 200% starting and 250% to 300% breakdown torque.

DIMENSIONS



Notes:

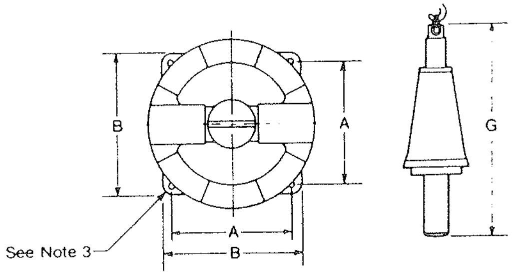
1. Minimum distance for removal of eccentric or hydraulic support.
2. Mimimum distance for counter-shaft removal.
3. Foundation bolts not furnished unless ordered separately.



(general dimensions only - not to be used for construction)

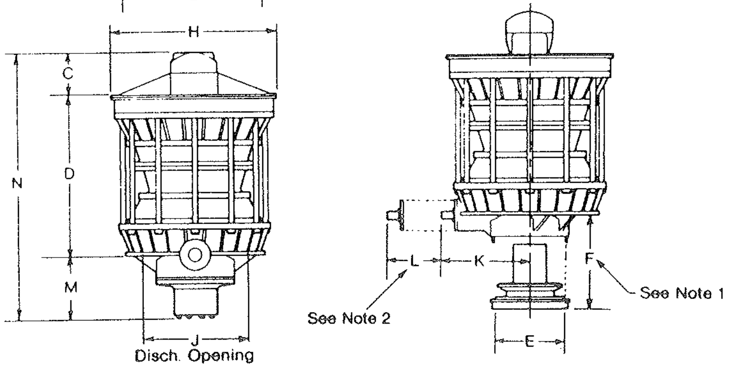
	30-60	42-70	48-75	54-75	60-90	60-110	72-112
A	8'-0"	9'-0"	10'-8"	10'-8"	14'-0"	14'-8"	20'-8"
B	9'-8"	11'-3"	13'-4"	13'-4"	16'-0"	16'-9"	21'-4"
C	4'-5"	3'-9"	3'-9-1/4"	3'-10-1/4"	4'-10-1/4"	4'-11"	4'-1-1/2"
D	8'-10-1/2"	12'-9-3/4"	14'-5/8"	14'-11-1/2"	17'-9-5/8"	19'-2"	21'-5-1/2"
E	5'-10"	6'-1"	6'-11"	6'-11"	8'-11"	8'-11"	10'-1"
F	6'-8"	7'-8-3/8"	8'-10-1/2"	8'-10-1/2"	10'-7-1/4"	10'-3"	12'-1"
G	13'-6-1/2"	17'-4-1/4"	19'-2-1/2"	20'-2-3/8"	24'-2-1/8"	25'-1"	27'-3"
H	10'-3"	13'-5"	15'-1"	16'-10"	19'-1"	19'-11"	22'-8"
J	9'-0"	10'-2"	12'-6"	12'-6"	14'-8"	15'-5"	17'-3-1/2"
K	7'-1"	8'-4"	8'-7-1/4"	8'-7-1/4"	10'-5/8"	10'-2-1/4"	12'-8"
L	3'-5"	4'-8"	5'-5-1/4"	5'-5-1/4"	6'-4-3/8"	6'-4-3/8"	8'-5"
M	2'2"	5'-7-5/8"	6'-3-5/8"	6'-3-5/8"	7'-2-1/4"	7'-10-1/4"	8'-4-1/4"
N	15'-5-1/2"	23'-10-3/8"	24'-1-1/2"	25'-1-3/8"	29'-10-5/8"	33'-10-3/8"	33'-11-1/4"

DIMENSIONS



Notes:

1. Minimum distance for removal of eccentric or hydraulic support.
2. Mimimum distance for counter-shaft removal.
3. Foundation bolts not furnished unless ordered separately.



(general dimensions only - not to be used for construction)

	762-1524 (30-60)	1067-1778 (42-70)	1219-1905 (48-75)	1372-1905 (54-75)	1524-2286 (60-90)	1524-2794 (60-110)	1825-2845 (72-112)
A	2438	2743	3251	3251	4267	4470	6096
B	2946	3429	4064	4064	4877	5105	6502
C	1346	1143	1149	1175	1494	1499	1257
D	2705	3905	4283	4559	5425	5842	6540
E	1524	1854	2108	2108	2718	2718	3073
F	2032	2346	2705	2705	3231	3124	3683
G	4128	5290	5855	6156	7371	7645	8306
H	3124	4089	4597	5131	5817	6071	6909
J	2743	3099	3810	3810	4470	4699	5270
K	2159	2540	2623	2623	3063	3105	3861
L	1041	1422	1657	1657	1940	1940	2565
M	660	1718	1921	1921	2190	2394	2546
N	4712	7274	7353	7655	9108	10322	10344

MATERIAL FRACTURE CHARACTERISTICS
TABLE A

Percent of Product Passing a Square Opening Equal to Open Side Setting of Crusher

Material Characteristics	Run of Mine (Quarry)	Crusher Product Only	Scalped Feed: Crusher Product And Grizzly Thrus Recombined
Soft	90	85	88
Soft (Spongy)	85	82	85
Average	90	85	85
Average (Slabby)	85	82	85
Hard (Brittle)	90	85	85
Hard (Tough)	82	75	80
Hard (Slabby)	75	70	75

PRODUCT ANALYSIS

Example:

Assuming the feed to be run of quarry granite (WI = 15.5) to a 5475 Nordberg Gyratory Crusher set at 6" O.S.S.

Table "A" shows 90% of product should pass a 6" square opening in flat testing screen. Follow the 90% horizontal line within the 6" O.S.S. block on Table "B". This line will yield the approximate screen analysis shown on the right.

Square Screen Opening In MM	Approx. % Passing
9"	99
8"	98
7"	96
6"	90
5"	78
4"	66
3"	50
2"	35
1-1/2"	28
1"	20
3/4"	16
1/2"	12

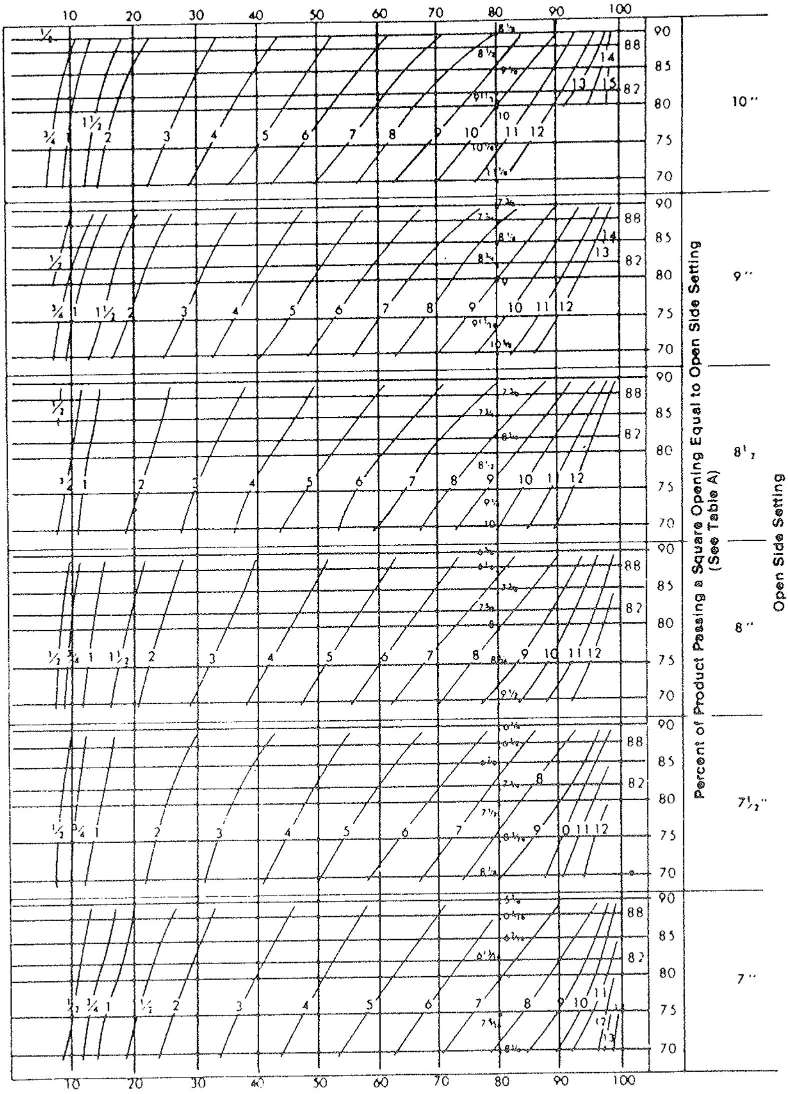
Work Index Guide:

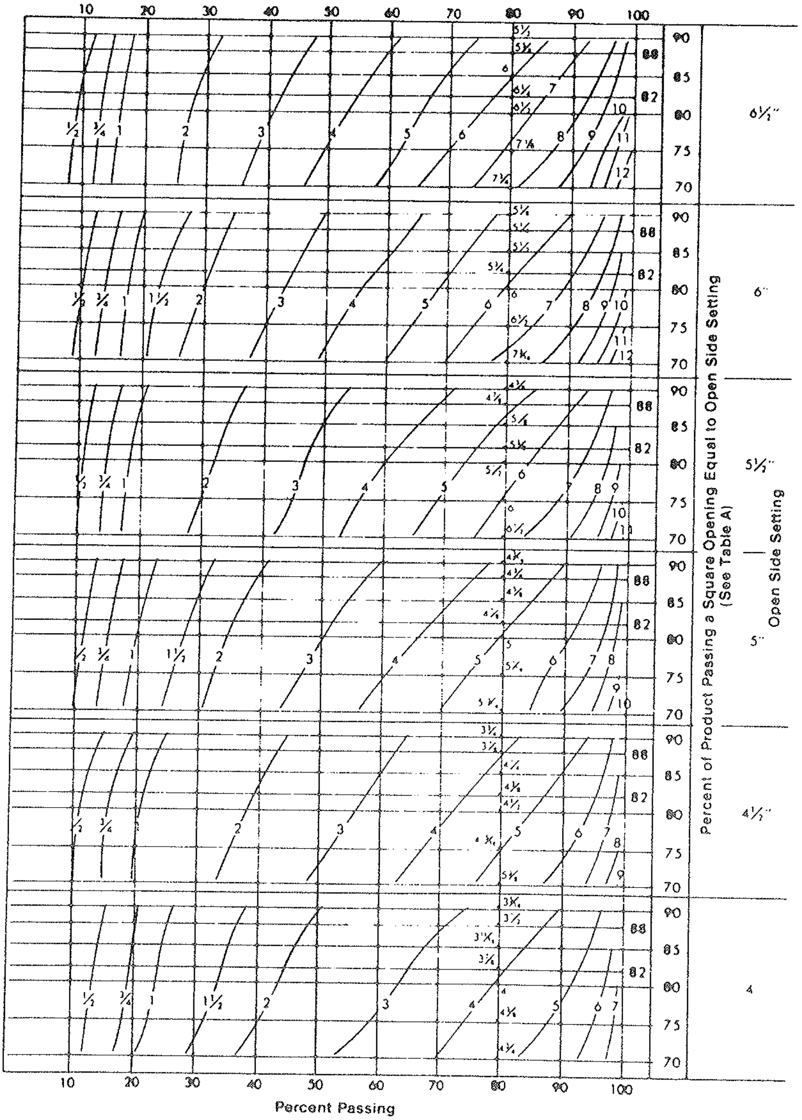
Soft - Impact Work Index of 5.0 to 10.0
Average - Impact Work Index of 10.0 to 13.0
Hard - Impact Work Index of 13.0 & Up

PRIMARY CRUSHER PRODUCT

TABLE B

Percent Passing





The above product gradations which represent square screen openings in inches yield the approximate screen analyses (See example of product analysis.)

FORMULA FOR HORSEPOWER DETERMINATION

Material (See Table A) ____________________

Wt. Cu. Ft. (Note 1) ____________________

Method of Feed ____________________ ROM or Scalped

Feed Size (F) = 80% Passes (Note 3) ____________ Inches

Product Size (P) = 80% Passes (Note 4) ____________ Inches

HP/Short Ton (Note 2) $= \frac{WI \times 0.084(\sqrt{F} - \sqrt{P})}{\sqrt{F} \times \sqrt{P}} =$ ____________

Feed Opening (A) ________ Inches

Open Side Setting (C) ________ Inches

Horsepower Correction Factor (HPCF) $= \frac{\sqrt{A}}{(0.125 \times A) + (0.318 \times C)}$

Total HP (Note 1) = Capacity in Short Tons/HR x HP/Short Ton x HPCF

NOTE 1
The capacity table can be found on page 2-2 of this manual, proportionally adjust the chosen capacity for specific bulk densities other than 1600 kg./cu. m. (100 lbs./cu. ft.).

NOTE 3
If the feed analysis is not available, experience dictates that 80% of the feed size will pass a square opening equal to from one-half to two-thirds of the crusher receiving opening.

NOTE 2
The WI value in the above formula is the impact work index. If not known this value can be determined at the Process Machinery Mineral Research and Test Center upon receipt of samples of the material to be crushed.

NOTE 4
To find product size (P) use table "A" to determine percent passing open side setting. Locate this value in the right hand margin of table "B" in the block for the open side setting selected. Follow this horizontal line to the 80% vertical line and read value of (P) in inches.

An Example for a Specific Application

Material: ROQ Granite — work index: 15.5

Crusher: 54-75 Nordberg Primary Gyratory Crusher
Open side setting: 6"
Eccentric throw: 1¼"
Capacity: 1530 short tons/HR
Max. design HP: 500

(From Capacity Table Page 2-2)

Feed size (F): 80% Passes 36" (⅔ of feed opening)

Product size (P): 80% Passes 5⅛" (from tables A & B)

HP/Short Ton $= \frac{15.5 \times 0.084(\sqrt{36} - \sqrt{5\frac{1}{8}})}{\sqrt{36} \times \sqrt{5\frac{1}{8}}} = 0.358$

Feed Opening (A) = 54 Inches

Open Side Setting (C) = 6 Inches

HPCF $= \frac{\sqrt{54}}{(0.125 \times 54) + (0.318 \times 6)} = 0.849$

Total HP = 1530 Short Tons/HR x 0.358 x 0.849 = 465 HP

* Always use Short Tons (2000 lbs.) from table on page 2-2.

MATERIAL FRACTURE CHARACTERISTICS
TABLE A

Percent of Product Passing a Square Opening Equal to Open Side Setting of Crusher

Material Characteristics	Run of Mine (Quarry)	Scalped Feed: Crusher Product Only	Scalped Feed: Crusher Product And Grizzly Thrus Recombined
Soft	90	85	88
Soft (Spongy)	85	82	85
Average	90	85	85
Average (Slabby)	85	82	85
Hard (Brittle)	90	85	85
Hard (Tough)	82	75	80
Hard (Slabby)	75	70	75

PRODUCT ANALYSIS

Example:

Assuming the feed to be run of quarry granite (WI = 15.5) to a 5475 Nordberg Gyratory Crusher set at 150 mm O.S.S.

Table "A" shows 90% of product should pass a 150 mm square opening in flat testing screen. Follow the 90% horizontal line within the 150 mm O.S.S. block on Table "B". This line will yield the approximate screen analysis shown on the right.

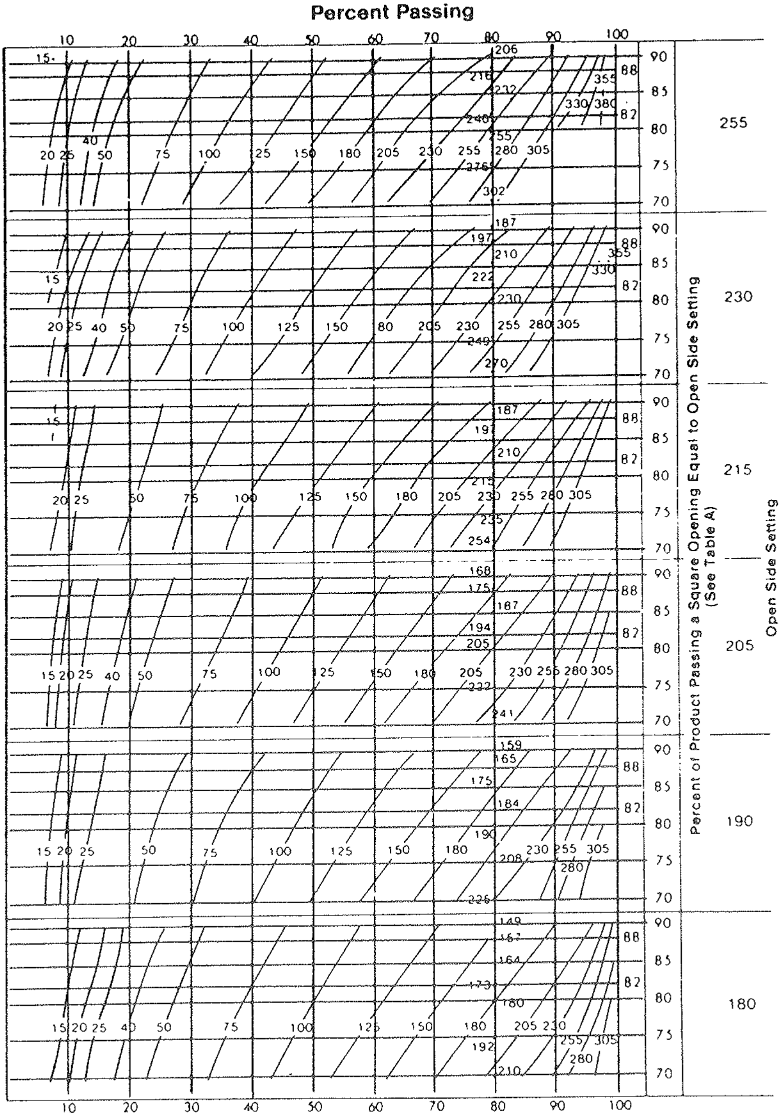
Square Screen Opening In MM	Approx. % Passing
230	99
205	98
180	96
150	90
125	78
100	66
75	50
50	35
40	28
25	20
20	16
15	12

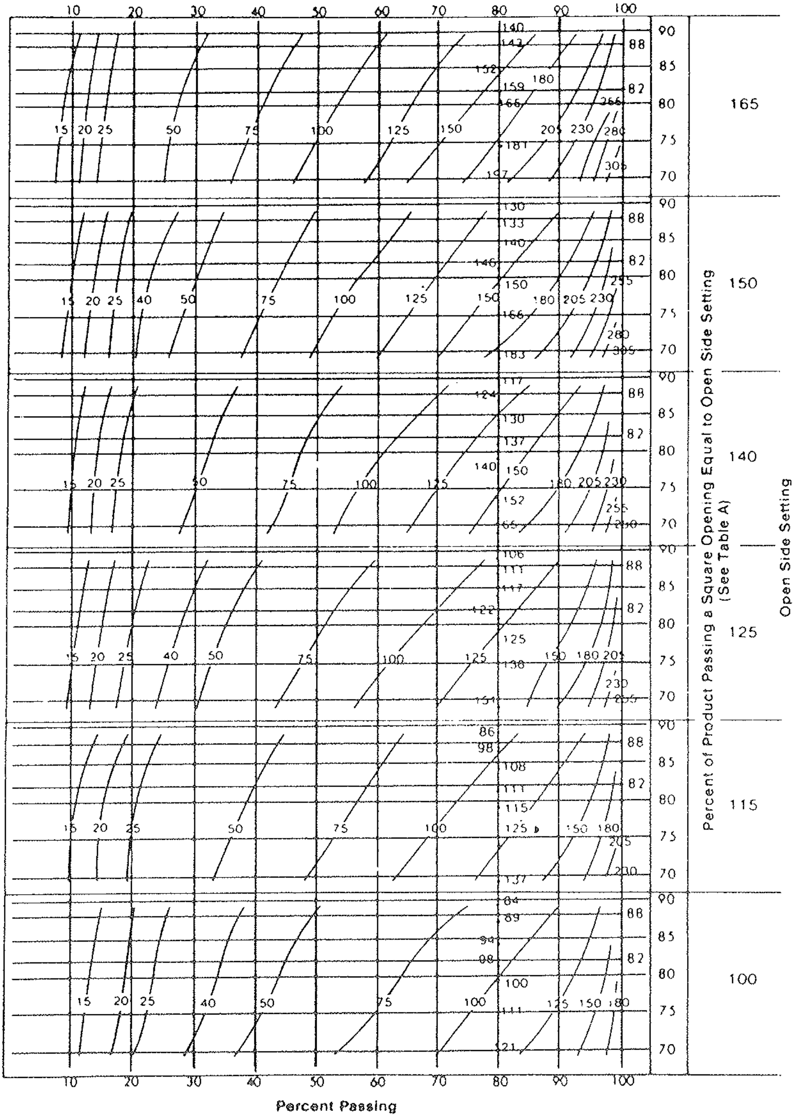
Work Index Guide:

Soft - Impact Work Index of 5.0 to 10.0
Average - Impact Work Index of 10.0 to 13.0
Hard - Impact Work Index of 13.0 & Up

PRIMARY CRUSHER PRODUCT

TABLE B





The above product gradations which represent square screen openings in millimeters yield the approximate screen analyses. (See example of product analysis.)

FORMULA FOR HORSEPOWER DETERMINATION

Material (See Table A) ______________________

Wt. Cu. Ft. (Note 1) ______________________

Method of Feed ______________________ ROM or Scalped

Feed Size (F) = 80% Passes (Note 3) ______________________ mm

Product Size (P) = 80% Passes (Note 4) ______________________ mm

$$\text{HP/Short Ton (Note 2)} = \frac{WI \times 0.424(\sqrt{F} - \sqrt{P})}{\sqrt{F} \times \sqrt{P}} = ______$$

Feed Opening (A) ____________ mm

Open Side Setting (C) ____________ mm

$$\text{Horsepower Correction Factor (HPCF)} = \frac{504\sqrt{A}}{(0.125 \times A) + (0.318 \times C)}$$

Total HP (Note 1) = Capacity in Short Tons/HR x HP/Short Ton x HPCF

NOTE 1

The capacity table can be found on page 2-2 of this manual, proportionally adjust the chosen capacity for specific bulk densities other than 100 lbs /cu ft

NOTE 3

If the feed analysis is not available, experience dictates that 80% of the feed size will pass a square opening equal to from one-half to two-thirds of the crusher receiving opening

NOTE 2

The WI value in the above formula is the impact work index. If not known this value can be determined at the Process Machinery Mineral Research and Test Center upon receipt of samples of the material to be crushed.

NOTE 4

To find product size (P) use table "A" to determine percent passing open side setting. Locate this value in the right hand margin of table "B" in the block for the open side setting selected. Follow this horizontal line to the 80% vertical line and read value of (P) in inches.

An Example for a Specific Application:

Material: ROQ Granite — work index: 15.5

Crusher: 54-75 Nordberg Primary Gyratory Crusher
Open side setting: 150mm
Eccentric throw: 32mm
*Capacity: 1530 short tons/HR
Max. design HP: 500

(From Capacity Table Page 2-2)

Feed size (F): 80% Passes 914mm (⅔ of feed opening)

Product size (P): 80% Passes 130mm (from tables A & B)

$$\text{HP/Short Ton} = \frac{15.5 \times 0.424(\sqrt{914} - \sqrt{130})}{\sqrt{914} \times \sqrt{130}} = 0.359$$

Feed Opening (A) = 1372mm

Open Side Setting (C) = 150mm

$$\text{HPCF} = \frac{5.04\sqrt{1372}}{(0.125 \times 1372) + (0.318 \times 152)} = 0.849$$

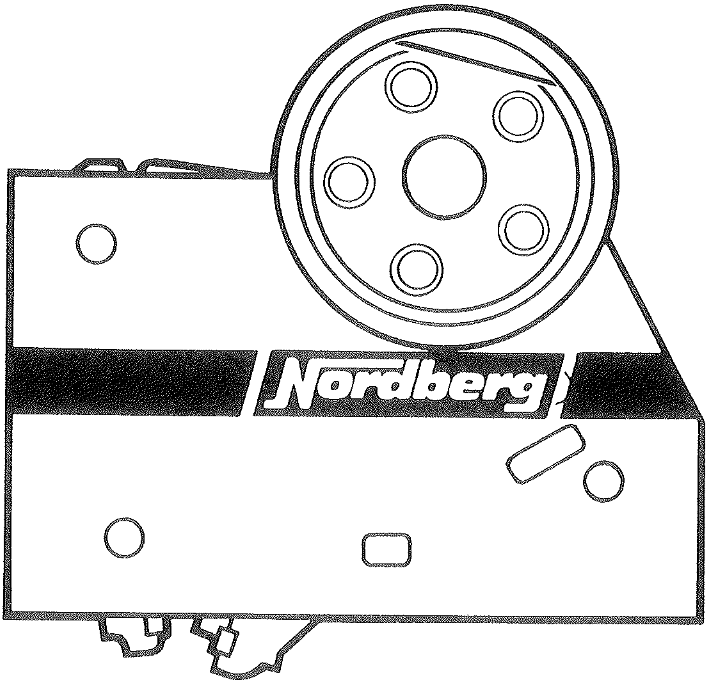
Total HP = 1530 Short Tons/HR x 0.359 x 0.849 = 466 HP

*Always use Short Tons (2000 lbs.) from table on page 15.

Nordberg®

A Nordberg Group Company

C-Series Jaw Crushers



THE NORDBERG C-SERIES JAW CRUSHER

Modular, lightweight construction withstands the most severe crushing applications

Nordberg, world leader in the manufacture and supply of crushing equipment, introduces the C-Series Jaw Crusher.

These crushers represent the best in jaw crusher design expertise: the highest possible technical and manufacturing know-how found anywhere today when it comes to primary reduction of hard abrasive materials.

Particularly well suited for portable or mobile plant use, like the revolutionary self-propelled Lokotrack, the C-Series Jaw presents a low profile, lightweight machine that stands up under the most severe crushing applications.

UNMATCHED FLEXIBILITY FOR SPECIAL APPLICATIONS

The bolted modular construction of the C-Series Jaw also presents unlimited flexibility in modifying the crusher to meet special customer needs for:

- Crushing applications requiring a smaller nip angle.
- Rip-rap models with special feed openings and discharge settings.
- Special breakdown for shipment and underground transportation.

HEAVY DUTY HARD ROCK CRUSHING CAPABILITY WITH LESS WEIGHT

The C-Series Jaw has a unique modular design that makes it weigh less than any other jaw crusher of comparable capacity, horsepower and durability.

The two rolled steel side plates are joined by special quality cast steel cross members through robust, precision machined bosses, aided by large diameter bolts.

The front header, the pitman and the transverse header are the cast steel components that take the brunt of the work. These cross members are produced of special Vaculok cast steel; a unique foundry process that provides fatigue strength, impact toughness and other properties superior to conventional steels.

This special high quality steel plus the use of Finite Element Computer Analysis results in a stronger, more durable hard rock crusher without adding unnecessary weight.

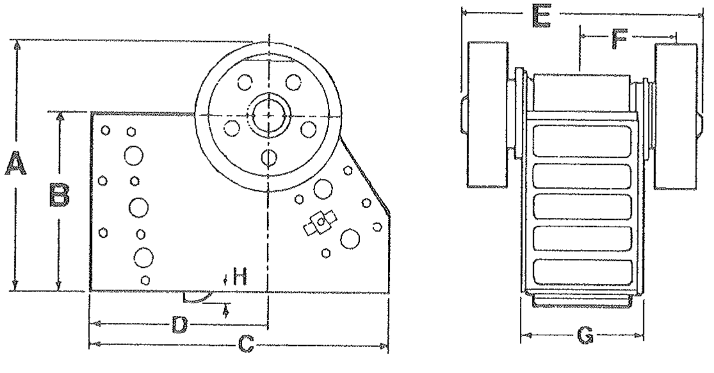
NORDBERG C-SERIES JAW CRUSHERS

TECHNICAL DATA

Crusher Size		C80B	C100B	C125B	C140B	C160B	C200B
Nominal Feed Opening	Inch	21 x 32	30 x 40	37 x 49	41 x 55	47 x 63	63 x 79
	(mm)	(530x800)	(750x1000)	(950x1250)	(1050x1400)	(1200x1600)	(1600x2000)
Total Weight	Lbs	23,150	44,320	80,925	101,980	148,840	295,470
	(Kg)	(10,500)	(20,100)	(36,700)	(46,250)	(67,500)	(134,000)
Power Electric	HP	100	150	200	250	300	400
	(KW)	(75)	(110)	(150)	(185)	(225)	(300)
Speed - RPM		300	260	220	220	200	180
Shaft Dia. Pitman Frame Brg	Inch	11.02	12.60	15.75	16.54	18.90	22.05
	(mm)	(280)	(320)	(400)	(420)	(480)	(560)
Length of Stationary Jaw	Inch	49.2	63.0	78.7	86.6	98.4	118.1
	(mm)	(1250)	(1600)	(2000)	(2200)	(2500)	(3000)
Flywheel Dia x Width	Inch	47.5x7.9	55.1x9.6	63.0x17.7	63.0x17.7	70.9x17.7	102.4x19.7
	(mm)	(1200x200)	(1400x245)	(1600x450)	(1600x450)	(1800x450)	(2600x500)
Max Lift for maint (Pitman less flywheel)	Lbs	9040	15,435	28,885	35,500	48,510	110,250
	(Kg)	(4100)	(7000)	(13,100)	(16,100)	(22,000)	(50,000)

DIMENSIONS

	C80B	C100B	C125B	C140B	C160B	C200B
A Inch	76.8	94.5	114.2	120.0	139.8	174.0
(mm)	(1950)	(2400)	(2900)	(3050)	(3550)	(4420)
B Inch	53.3	66.9	82.7	88.6	104.3	122.0
(mm)	(1350)	(1700)	(2100)	(2250)	(2650)	(3100)
C Inch	94.5	113.4	132.7	140.9	165.4	196.9
(mm)	(2400)	(2880)	(3370)	(3580)	(4200)	(5000)
D Inch	53.8	67.9	82.3	91.7	100.0	128.7
(mm)	(1367)	(1725)	(2090)	(2330)	(2540)	(3270)
E Inch	67.2	88.6	105.8	113.8	125.3	155.5
(mm)	(1708)	(2250)	(2688)	(2890)	(3182)	(3950)
F Inch	26.2	32.2	42.3	46.1	51.8	66.9
(mm)	(665)	(818)	(1074)	(1172)	(1315)	(1700)
G Inch	37.0	46.1	57.9	64.6	74.0	94.5
(mm)	(940)	(1170)	(1470)	(1640)	(1880)	(2400)
H Inch	6.3	9.3	11.0	11.4	13.4	13.8
(mm)	(159)	(237)	(280)	(290)	(340)	(350)



NORDBERG C-SERIES JAW CRUSHER CAPACITIES

SHORT TONS

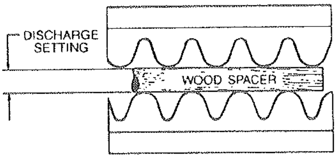
Closed Side Setting Inch	Crusher Size					
	C80B	C100B	C125B	C140B	C160B	C200B
1-1/2	60-75					
2	70-85	95-110				
2-1/2	90-110	110-140				
3	105-125	120-160	200-235			
3-1/2	110-135	140-180	210-250			
4	120-150	175-220	220-275	280-330		
4-1/2	130-170	190-245	240-295	310-375		
5		225-280	270-345	350-425	400-475	
6		255-325	340-400	395-500	450-530	
7			385-480	475-570	520-600	600-690
8			450-545	545-645	590-680	680-775
9				600-715	660-750	750-850
10				665-780	730-830	830-940
11					800-900	920-1040
12					875-1000	1020-1150
13						1140-1270
14						1250-1400
15						

The above capacities are based on average feed material weighing 100 lbs. per cubic foot crushed of a size which will readily enter the crushing chamber without bridging.

Capacities shown may vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, bulk density and fracture characteristics of the feed. Undersize material should be removed from crusher feed to eliminate packing and excessive wear on the jaw dies.

Settings greater than indicated are within the design capabilities of the machines but are not shown due to anticipated higher operating costs. For these special applications or settings smaller than indicated, consult factory.

CRUSHER SETTING MEASUREMENT



The C-Series Jaw Crusher comes to rest in the closed position. To convert from open side setting to closed side setting use the chart shown below. Find the correct size jaw crusher and subtract the "Setting Offset" from the measured open side setting and you get the closed side setting.

Jaw Size	C80	C100	C125	C140	C160
Setting Offset	1"	1"	1.42"	1.34"	1.36"

NORDBERG C-SERIES JAW CRUSHER CAPACITIES

METRIC TONS

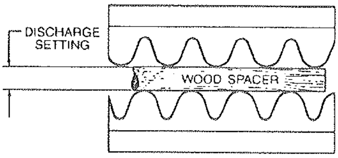
Closed Side Setting mm	Crusher Size					
	C80B	C100B	C125B	C140B	C160B	C200B
38	54-68					
51	64-77	86-100				
64	82-100	100-127				
76	05-113	109-145	181-213			
89	100-122	127-163	190-227			
102	109-136	159-200	200-249	254-299		
114	118-154	172-222	218-268	281-340		
127		204-254	245-313	318-386	363-431	
152		231-295	308-363	358-454	408-481	
178			349-435	431-517	472-544	544-626
203			408-494	494-585	535-617	617-703
229				544-649	599-680	680-771
254				608-708	662-753	753-853
279					726-816	835-943
305					794-907	925-1043
330						1043-1152
356						1134-1270
381						

The above capacities are based on average feed material weighing 1602 kg per cubic meter crushed of a size which will readily enter the crushing chamber without bridging.

Capacities shown may vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, bulk density and fracture characteristics of the feed. Undersize material should be removed from crusher feed to eliminate packing and excessive wear on the jaw dies.

Settings greater than indicated are within the design capabilities of the machines but are not shown due to anticipated higher operating costs. For these special applications or settings smaller than indicated, consult factory.

CRUSHER SETTING MEASUREMENT



The C-Series Jaw Crusher comes to rest in the closed position. To convert from open side setting to closed side setting use the chart shown below. Find the correct size jaw crusher and subtract the "Setting Offset" from the measured open side setting and you get the closed side setting.

Jaw Size	C80	C100	C125	C140	C160
Setting Offset	25mm	25mm	36mm	34mm	34.5mm

TYPICAL PRODUCT GRADATIONS
Feed Material Rating - Average
(Nordberg C-Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Jaw Crusher Discharge Setting -- Inches												
	1.5	2	2.5	3	3.5	4	4.5	5	6	7	8	9	10
13													100
12												100	96
11											100	97	91
10										100	98	91	85
9									100	97	92	85	77
8							100	100	97	92	85	77	70
7						100	98	97	92	85	76	68	60
6					100	98	95	93	85	74	65	57	49
5				100	98	96	90	85	72	62	52	47	39
4.5				98	94	89	85	75	62	53	45	39	35
4			100	97	92	85	75	70	56	45	40	34	29
3.5			98	92	85	73	65	58	48	40	33	28	26
3		100	93	85	72	62	55	49	38	32	27	24	22
2.5	100	98	85	72	60	53	45	40	34	24	23	20	18
2	98	85	67	56	47	41	37	34	29	20	18	17	14
1.75	89	73	58	49	40	36	32	30	26	18	16	14	13
1.5	85	64	49	42	37	33	29	27	23	16	14	13	12
1.25	70	55	43	36	33	30	25	24	19	14	13	12	11
1	56	44	36	30	28	26	22	20	17	12	12	11	10
3/4	42	34	29	25	22	20	17	16	13	11	10	9	8
1/2	33	25	23	19	17	14	13	12	10	8	8	7	6
1/4	20	15	13	12	11	10	8	7	6	5	4	4	3

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

TYPICAL PRODUCT GRADATION
Feed Material Rating - Average
(Nordberg C-Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Milli-meters	Jaw Crusher Discharge Setting -- Millimeters												
	38	51	64	76	89	102	114	127	152	178	203	229	254
330													100
305												100	96
279											100	97	91
254										100	98	91	85
229									100	97	92	85	77
203							100	100	97	92	85	77	70
179						100	98	97	92	85	76	68	60
152					100	98	95	93	85	74	65	57	49
127				100	98	96	90	85	72	62	52	47	39
114				98	94	89	85	75	62	53	45	39	35
102			100	97	92	85	75	70	56	45	40	34	29
89			98	92	85	73	65	58	48	40	33	28	26
76		100	93	85	72	62	55	49	38	32	27	24	22
64	100	98	85	72	60	53	45	40	34	24	23	20	18
51	98	85	67	56	47	41	37	34	29	20	18	17	14
44	89	73	58	49	40	36	32	30	26	18	16	14	13
38	85	64	49	42	37	33	29	27	23	16	14	13	12
32	70	55	43	36	33	30	25	24	19	14	13	12	11
25	56	44	36	30	28	26	22	20	17	12	12	11	10
19	42	34	29	25	22	20	17	16	13	11	10	9	8
13	33	25	23	19	17	14	13	12	10	8	8	7	6
6	20	15	13	12	11	10	8	7	6	5	4	4	3

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

TYPICAL PRODUCT GRADATIONS
Feed Material Rating - Hard
(Nordberg C-Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Jaw Crusher Discharge Setting -- Inches												
	1.5	2	2.5	3	3.5	4	4.5	5	6	7	8	9	10
19													100
18												100	99
16											100	98	96
15											99	97	95
14										100	98	96	92
13										99	96	93	89
12									100	97	95	90	84
11									99	96	91	85	78
10								100	97	93	87	79	70
9							100	98	95	88	80	70	60
8						100	98	96	90	81	70	60	52
7					100	98	96	92	82	70	58	50	45
6				100	97	95	90	84	70	57	48	43	39
5			100	97	93	87	79	70	55	46	40	36	33
4.5			98	95	88	80	70	60	48	42	37	33	30
4		100	96	90	81	70	60	52	43	37	33	29	27
3.5		98	92	82	70	58	50	45	38	33	29	26	24
3	100	95	84	70	57	48	43	39	33	28	25	23	21
2.5	97	87	70	55	46	40	36	33	28	24	22	20	19
2	90	70	52	43	37	33	29	27	23	20	19	17	16
1.75	82	58	45	38	33	29	26	24	21	19	17	15	14
1.5	70	48	39	33	28	25	23	21	19	17	15	14	13
1.25	55	40	33	28	24	22	20	19	16	14	13	12	11
1	43	33	27	23	20	19	17	16	14	12	11	10	10
3/4	33	25	21	19	17	15	14	13	11	10	9	9	8
1/2	23	19	16	14	12	11	10	10	9	8	7	7	6
1/4	14	11	10	9	8	7	7	6	6	5	5	5	4

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

TYPICAL PRODUCT GRADATIONS
Feed Material Rating - Hard
(Nordberg C-Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Milli-meters	Jaw Crusher Discharge Setting -- Millimeters												
	38	51	64	76	89	102	114	127	152	178	203	229	254
483													100
457												100	99
406											100	98	96
381											99	97	95
356										100	98	96	92
330										99	96	93	89
305									100	97	95	90	84
279									99	96	91	85	78
254								100	97	93	87	79	70
229							100	98	95	88	80	70	60
203						100	98	96	90	81	70	60	52
179					100	98	96	92	82	70	58	50	45
152				100	97	95	90	84	70	57	48	43	39
127			100	97	93	87	79	70	55	46	40	36	33
114			98	95	88	80	70	60	48	42	37	33	30
102		100	96	90	81	70	60	52	43	37	33	29	27
89		98	92	82	70	58	50	45	38	33	29	26	24
76	100	95	84	70	57	48	43	39	33	28	25	23	21
64	97	87	70	55	46	40	36	33	28	24	22	20	19
51	90	70	52	43	37	33	29	27	23	20	19	17	16
44	82	58	45	38	33	29	26	24	21	19	17	15	14
38	70	48	39	33	28	25	23	21	19	17	15	14	13
32	55	40	33	28	24	22	20	19	16	14	13	12	11
25	43	33	27	23	20	19	17	16	14	12	11	10	10
19	33	25	21	19	17	15	14	13	11	10	9	9	8
13	23	19	16	14	12	11	10	10	9	8	7	7	6
6	14	11	10	9	8	7	7	6	6	5	5	5	4

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

NOTES

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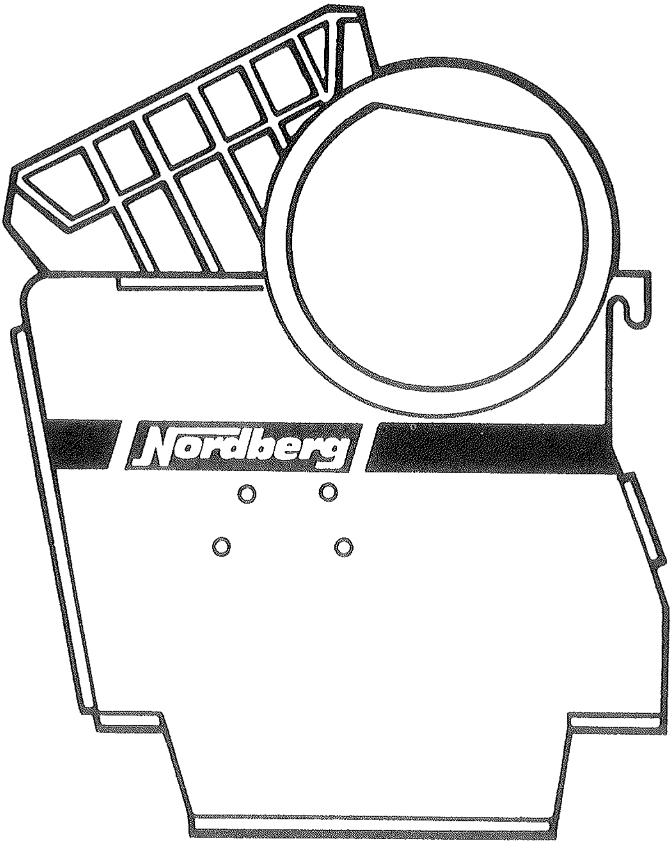
VB Jaw Crushers



NORDBERG VB JAW CRUSHERS SPECIFICATIONS

(Nordberg VB Series)

SPECIFICATIONS	VB0806	VB0907	VB1008	VB1109	VB1311	VB1512
SIZE OF FEED OPENING Length: Width:	32 in (800mm) 24 in (600mm)	36 in (900mm) 28 in (700mm)	40 in (1000mm) 32 in (900mm)	45 in (1130mm) 36 in (900mm)	52 in (1332mm) 43 in (1200mm)	60 in (1540mm) 47 in (1200mm)
TOTAL WEIGHT OF CRUSHER (Feed Hopper Included)	33,210 lbs (15,060kgs)	44,870 lbs (20,350kgs)	61,080 lbs (27,700kgs)	79,050 lbs (35,850kgs)	120,170 lbs (54,500kgs)	200,655 lbs (91,000kgs)
WEIGHT OF FEED HOPPER	2040 lbs (925kgs)	2800 lbs (127kgs)	3530 lbs (1600kgs)	3750 lbs (1700kgs)	4630 lbs (2100kgs)	3750 lbs (1700kgs)
JAW PLATES	1 piece-reversible	1 piece-reversible/ interchangeable	1 piece-reversible/ interchangeable	1 piece-reversible/ interchangeable	1 piece-reversible/ interchangeable	1 piece-reversible/ interchangeable
WEIGHT OF ONE JAW PLATE	2405 lbs (1090kgs)	2315 lbs (1050kgs)	2712 lbs (1230kgs)	3340 lbs (1510kgs)	3418 lbs (1550kgs)	1808 lbs (825kgs)
SPEED OF CRUSHER	300 RPM	250 RPM	225 RPM	225 RPM	200 RPM	180 RPM
POWER (ELECTRIC)	100 HP (75 KW)	125 HP (93 KW)	150 HP (112 KW)	200 HP (150 KW)	250 HP (186 KW)	300 HP (225 KW)
FLYWHEEL Diameter: Width:	51.6 in (1310mm) 9.88 in (250mm)	51.6 in (1310mm) 11.8 in (300mm)	64.6 in (1640mm) 9.06 in (230mm)	64.6 in (1640mm) 9.06 in (230mm)	75.2 in (1910mm) 12.6 in (320mm)	89.2 in (2266mm) 14.8 in (370mm)
V-BELT DRIVE Number & Size:	5-8V Belts	5-8V Belts	6-8V Belts	6-8V Belts	8-8V Belts	9-8V Belts
MAXIMUM LIFT FOR MAINTENANCE[1]	11,200 lbs (5080kgs)	14,685 lbs (6660kgs)	18,150 lbs (8230kgs)	25,903 lbs (11,760kgs)	37,990 lbs (17,230kgs)	61,740 lbs (28,000kgs)
HYDRAULIC PACKAGE[2]	Included	Included	Included	Included	Included	Included

1. Pitman Assembly Less Flywheels 2. Includes Jaw Plate Removal, Discharge Setting Adjustment, Toggle Plate Replacement

NORDBERG VB JAW CRUSHER CAPACITIES
SHORT TONS (METRIC TOMS)

Closed Side Setting Inch (mm)	Crusher Size					
	VB0806	VB0907	VB1008	VB1109	VB1311	VB1512
1-1/2 (38)						
2 (51)	65-80 (59-73)					
2-1/2 (64)	85-105 (77-95)	100-120 (91-109)				
3 (76)	100-120 (91-109)	110-125 (100-113)				
3-1/2 (89)	105-130 (95-118)	120-140 (109-127)	125-160 (113-145)			
4 (102)	115-145 (104-132)	145-165 (131-150)	170-210 (154-190)	210-260 (190-236)		
4-1/2 (114)	120-155 (109-141)	155-180 (141-163)	185-235 (168-213)	230-280 (209-254)	300-365 (272-331	
5 (127)	130-170 (118-154)	170-210 (154-191)	210-265 (190-240)	260-330 (236-299)	340-410 (308-372)	390-510 (354-463)
6 (152)		200-250 (182-227)	250-315 (227-286)	325-385 (295-349)	385-490 (349-444)	430-575 (390-522)
7 (178)			300-370 (272-336)	370-460 (336-417)	465-555 (422-503)	515-675 (467-612)
8 (203)			360-430 (326-390)	430-520 (390-472)	530-325 (481-567)	585-770 (531-698)
9 (229)				500-590 (454-535)	590-695 (535-630)	640-825 (580-750)
10 (254)						695-935 (630-850)

The above capacities are based on average feed material weighing 100 lbs. per cubic foot crushed (1602 kg per cubic meter) of a size which will readily enter the crushing chamber without bridging.

Capacities shown may vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, bulk density and fracture characteristics of the feed. Undersize material should be removed from crusher feed to eliminate packing and excessive wear on the jaw dies.

Settings greater than indicated are within the design capabilities of the machines but are not shown due to anticipated higher operating costs. For these special applications or settings smaller than indicated, consult factory.

TYPICAL PRODUCT GRADATIONS
Feed Material Rating - Average
(Nordberg VB Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Jaw Crusher Discharge Setting -- Inches												
	1.5	2	2.5	3	3.5	4	4.5	5	6	7	8	9	10
13													100
12												100	96
11											100	97	91
10										100	98	91	85
9									100	97	92	85	77
8							100	100	97	92	85	77	70
7						100	98	97	92	85	76	68	60
6					100	98	95	93	85	74	65	57	49
5				100	98	96	90	85	72	62	52	47	39
4.5				98	94	89	85	75	62	53	45	39	35
4			100	97	92	85	75	70	56	45	40	34	29
3.5			98	92	85	73	65	58	48	40	33	28	26
3		100	93	85	72	62	55	49	38	32	27	24	22
2.5	100	98	85	72	60	53	45	40	34	24	23	20	18
2	98	85	67	56	47	41	37	34	29	20	18	17	14
1.75	89	73	58	49	40	36	32	30	26	18	16	14	13
1.5	85	64	49	42	37	33	29	27	23	15	14	13	12
1.25	70	55	43	36	33	30	25	24	19	14	13	12	11
1	56	44	36	30	28	26	22	20	17	12	12	11	10
3/4	42	34	29	25	22	20	17	16	13	11	10	9	8
1/2	33	25	23	19	17	14	13	12	10	8	8	7	6
3/8	25	20	18	16	14	12	10	9	8	7	6	5	5
1/4	20	15	13	12	11	10	8	7	6	5	4	4	3

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

TYPICAL PRODUCT GRADATION
Feed Material Rating - Average
(Nordberg VB Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Millimeters	Jaw Crusher Discharge Setting -- Millimeters												
	38	51	64	76	89	102	114	127	152	178	203	229	254
330													100
305												100	96
279											100	97	91
254										100	98	91	85
229									100	97	92	85	77
203							100	100	97	92	85	77	70
179						100	98	97	92	85	76	68	60
152					100	98	95	93	85	74	65	57	49
127				100	98	96	90	85	72	62	52	47	39
114				98	94	89	85	75	62	53	45	39	35
102			100	97	92	85	75	70	56	45	40	34	29
89			98	92	85	73	65	58	48	40	33	28	26
76		100	93	85	72	62	55	49	38	32	27	24	22
64	100	98	85	72	60	53	45	40	34	24	23	20	18
51	98	85	67	56	47	41	37	34	29	20	18	17	14
44	89	73	58	49	40	36	32	30	26	18	16	14	13
38	85	64	49	42	37	33	29	27	23	15	14	13	12
32	70	55	43	36	33	30	25	24	19	14	13	12	11
25	56	44	36	30	28	26	22	20	17	12	12	11	10
19	42	34	29	25	22	20	17	16	13	11	10	9	8
13	33	25	23	19	17	14	13	12	10	8	8	7	6
9	25	20	18	16	14	12	10	9	8	7	6	5	5
6	20	15	13	12	11	10	8	7	6	5	4	4	3

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

TYPICAL PRODUCT GRADATIONS

Feed Material Rating - Hard
(Nordberg VB Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Jaw Crusher Discharge Setting -- Inches												
	1.5	2	2.5	3	3.5	4	4.5	5	6	7	8	9	10
19													100
18												100	99
16											100	98	96
15											99	97	95
14										100	98	96	92
13										99	96	93	89
12									100	97	95	90	84
11									99	96	91	85	78
10								100	97	93	87	79	70
9							100	98	95	88	80	70	60
8						100	98	96	90	81	70	60	52
7					100	98	96	92	82	70	58	50	45
6				100	97	95	90	84	70	57	48	43	39
5			100	97	93	87	79	70	55	46	40	36	33
4.5			98	95	88	80	70	60	48	42	37	33	30
4		100	96	90	81	70	60	52	43	37	33	29	27
3.5		98	92	82	70	58	50	45	38	33	29	26	24
3	100	95	84	70	57	48	43	39	33	28	25	23	21
2.5	97	87	70	55	46	40	36	33	28	24	22	20	19
2	90	70	52	43	37	33	29	27	23	20	19	17	16
1.75	82	58	45	38	33	29	26	24	21	19	17	15	14
1.5	70	48	39	33	28	25	23	21	19	17	15	14	13
1.25	55	40	33	28	24	22	20	19	16	14	13	12	11
1	43	33	27	23	20	19	17	16	14	12	11	10	10
3/4	33	25	21	19	17	15	14	13	11	10	9	9	8
1/2	23	19	16	14	12	11	10	10	9	8	7	7	6
1/4	14	11	10	9	8	7	7	6	6	5	5	5	4

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

TYPICAL PRODUCT GRADATIONS
Feed Material Rating - Hard
(Nordberg VB Series)

Open Circuit Product Analysis (% Passing) for Given Closed Side Setting of Crusher

Product Size Milli-meters	Jaw Crusher Discharge Setting -- Millimeters												
	38	51	64	76	89	102	114	127	152	178	203	229	254
483													100
457												100	99
406											100	98	96
381											99	97	95
356										100	98	96	92
330										99	96	93	89
305									100	97	95	90	84
279									99	96	91	85	78
254								100	97	93	87	79	70
229							100	98	95	88	80	70	60
203						100	98	96	90	81	70	60	52
179					100	98	96	92	82	70	58	50	45
152				100	97	95	90	84	70	57	48	43	39
127			100	97	93	87	79	70	55	46	40	36	33
114			98	95	88	80	70	60	48	42	37	33	30
102		100	96	90	81	70	60	52	43	37	33	29	27
89		98	92	82	70	58	50	45	38	33	29	26	24
76	100	95	84	70	57	48	43	39	33	28	25	23	21
64	97	87	70	55	46	40	36	33	28	24	22	20	19
51	90	70	52	43	37	33	29	27	23	20	19	17	16
44	82	58	45	38	33	29	26	24	21	19	17	15	14
38	70	48	39	33	28	25	23	21	19	17	15	14	13
32	55	40	33	28	24	22	20	19	16	14	13	12	11
25	43	33	27	23	20	19	17	16	14	12	11	10	10
19	33	25	21	19	17	15	14	13	11	10	9	9	8
13	23	19	16	14	12	11	10	10	9	8	7	7	6
6	14	11	10	9	8	7	7	6	6	5	5	5	4

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

NOTES

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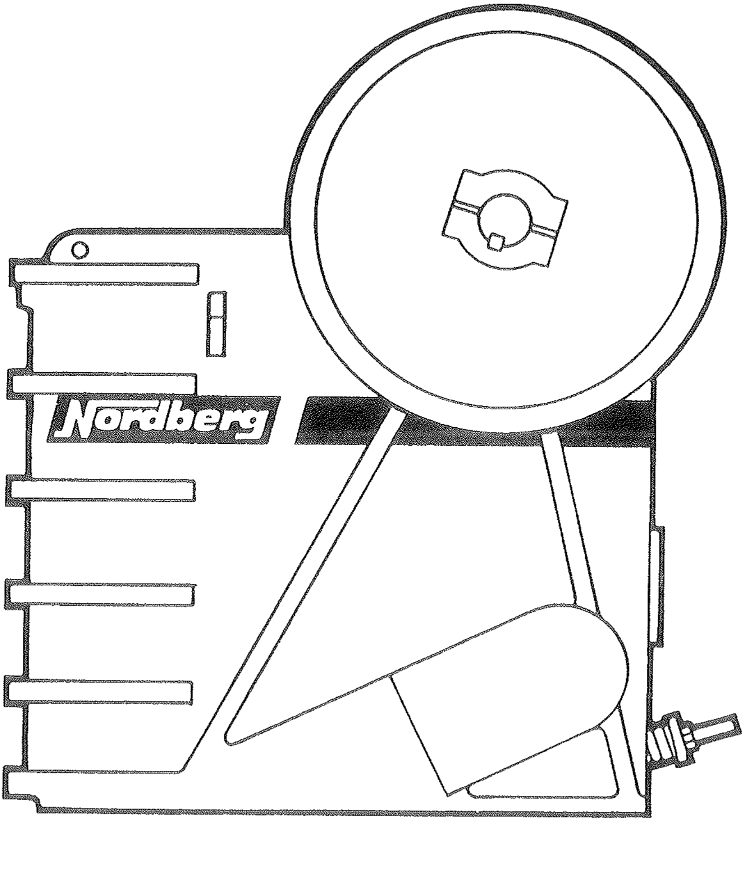
Missouri Rogers Jaw Crushers



HEAVY-DUTY JAW CRUSHERS

(Missouri Rogers Series)

Crusher Size	1236	1836	2136	2436	2540
Recommended Motor Horsepower (Electric)	75	75	75	100	100
Speed (R.P.M.)	275	250	250	250	225
Approx. Wt. (Lbs.) (Kgs.)	13,700 6,200	20,800 9,400	24,500 11,110	24,600 11,160	38,900 17,600
Movable Jaw Length (Inches) (mm)	31-1/4" 800	40 1000	51 1300	51 1300	64-1/2" 1640
Stationary Jaw Length (Inches) (mm)	27 700	35-1/4" 900	46-1/2" 1200	46-1/2" 1200	56-1/2" 1435
Eccentric	4140 forged and heat treated alloy steel				
Ecc. Shaft Dia. in Side Bearings (Inches) (mm)	5-5/16" 135	5-15/16" 151	5-15/16" 151	5-15/16" 151	7-1/16" 179
Ecc. Shaft Dia. in Pitman Bearings (Inches) (mm)	7-1/16" 180	7-1/2" 190	7-1/2" 190	7-1/2" 190	8-11/16" 220

Crusher Size	3040	3240	3648	4248
Recommended Motor Horsepower (Electric)	125	150	200	200
Speed (R.P.M.)	225	225	235	235
Approx. Wt. (Lbs.) (Kgs.)	39,200 17,800	52,900 24,000	99,800 45,300	100,200 45,500
Movable Jaw Length (Inches) (mm)	64-1/2" 1640	74-1/2" 1900	94 2400	94 2400
Stationary Jaw Length (Inches) (mm)	56-1/2" 1435	68 1700	84 2100	84 2100
Eccentric				
Ecc. Shaft Dia. in Side Bearings (Inches) (mm)	7-1/16" 179	7-7/8" 200	11" 279	11" 279
Ecc. Shaft Dia. in Pitman Bearings (Inches) (mm)	8-11/16" 220	11" 280	14-3/16" 360	14-3/16" 360

JAW CRUSHER CAPACITIES
SHORT TONS (METRIC TOMS)
(Missouri Rogers Series)

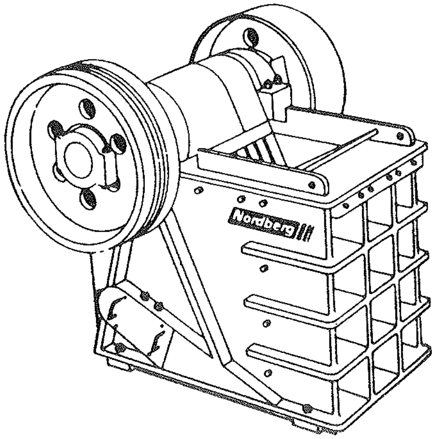
Discharge Setting Inch (mm)	Crusher Size								
	1236	1836	2136	2436	2540	3040	3240	3648	4248
1-1/2 (38)	50 (45)								
2 (51)	70 (63)	70 (63)							
2-1/2 (64)	85 (77)	85 (77)	85 (77)						
3 (76)	100 (91)	100 (91)	100 (91)	100 (91)	125 (113)				
3-1/2 (89)	120 (109)	120 (109)	120 (109)	120 (109)	150 (136)	150 (136)			
4 (102)	135 (122)	135 (122)	135 (122)	135 (122)	175 (159)	175 (159)	175 (159)		
4-1/2 (114)	150 (136)	150 (136)	150 (136)	150 (136)	200 (181)	200 (181)	200 (181)	275 (249)	
5 (127)		165 (150)	165 (150)	165 (150)	225 (204)	225 (204)	225 (204)	340 (308)	340 (308)
6 (152)			190 (172)	190 (172)	275 (249)	275 (249)	275 (249)	410 (372)	410 (372)
7 (178)				220 (199)	325 (295)	325 (295)	325 (295)	475 (431)	475 (431)
8 (203)						380 (347)	380 (347)	545 (494)	545 (494)
9 (229)							420 (381)	615 (557)	615 (557)
10 (254)								680 (617)	680 (617)

Please see notes on the following page.

The above capacities are based on short tons per hour (2,000 lbs.) and metric tons per hour (2205 kgs.) of average feed material weighing 100 lbs. per cubic foot or 1600 kgs. per cubic meter (crushed) of a size which will readily enter the crushing chamber without bridging.

Capacities shown may vary ± 25% depending on the type of material, gradation of feed, method of feeding, moisture and clay content, bulk density and fracture characteristics of the feed. Undersize material should be removed from crusher feed to eliminate packing and excessive wear on the jaw dies.

Settings greater than indicated are within the design capabilities of the machines but are not shown due to anticipated higher operating costs. For these special applications or settings smaller than indicated, consult factory.



PRODUCT ANALYSIS INFORMATION
Feed Material Rating - Average
(Missouri Rogers Series)

CUMULATIVE PERCENT PASSING

Product Size Inches	Jaw Crusher Discharge Setting -- Inches												
	1.5	2	2.5	3	3.5	4	4.5	5	6	7	8	9	10
13													100
12												100	96
11											100	97	91
10										100	98	91	85
9									100	97	92	85	77
8							100	100	97	92	85	77	70
7						100	98	97	92	85	76	68	60
6					100	98	95	93	85	74	65	57	49
5				100	98	96	90	85	72	62	52	47	39
4.5				98	94	89	85	75	62	53	45	39	35
4			100	97	92	85	75	70	56	45	40	34	29
3.5			98	92	85	73	65	58	48	40	33	28	26
3		100	93	85	72	62	55	49	38	32	27	24	22
2.5	100	98	85	72	60	53	45	40	34	24	23	20	18
2	98	85	67	56	47	41	37	34	29	20	18	17	14
1.75	89	73	58	49	40	36	32	30	26	18	16	14	13
1.5	85	64	49	42	37	33	29	27	23	15	14	13	12
1.25	70	55	43	36	33	30	25	24	19	14	13	12	11
1	56	44	36	30	28	26	22	20	17	12	12	11	10
3/4	42	34	29	25	22	20	17	16	13	11	10	9	8
1/2	33	25	23	19	17	14	13	12	10	8	8	7	6
3/8	25	20	18	16	14	12	10	9	8	7	6	5	5
1/4	20	15	13	12	11	10	8	7	6	5	4	4	3
4M	15	12	10	9	8	7	6	6	5	4	3	2	2
8M	9	8	7	6	6	5	5	4	4	3	2	1	1

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

PRODUCT ANALYSIS INFORMATION

Feed Material Rating - Average
(Missouri Rogers Series)

CUMULATIVE PERCENT PASSING

Product Size Milli-meters	Jaw Crusher Discharge Setting -- Millimeters												
	38	51	64	76	89	102	114	127	152	178	203	229	254
330													100
305												100	96
279											100	97	91
254										100	98	91	85
229									100	97	92	85	77
203							100	100	97	92	85	77	70
179						100	98	97	92	85	76	68	60
152					100	98	95	93	85	74	65	57	49
127				100	98	96	90	85	72	62	52	47	39
114				98	94	89	85	75	62	53	45	39	35
102			100	97	92	85	75	70	56	45	40	34	29
89			98	92	85	73	65	58	48	40	33	28	26
76		100	93	85	72	62	55	49	38	32	27	24	22
64	100	98	85	72	60	53	45	40	34	24	23	20	18
51	98	85	67	56	47	41	37	34	29	20	18	17	14
44	89	73	58	49	40	36	32	30	26	18	16	14	13
38	85	64	49	42	37	33	29	27	23	15	14	13	12
32	70	55	43	36	33	30	25	24	19	14	13	12	11
25	56	44	36	30	28	26	22	20	17	12	12	11	10
19	42	34	29	25	22	20	17	16	13	11	10	9	8
13	33	25	23	19	17	14	13	12	10	8	8	7	6
9	25	20	18	16	14	12	10	9	8	7	6	5	5
6	20	15	13	12	11	10	8	7	6	5	4	4	3
5	15	12	10	9	8	7	6	6	5	4	3	2	2
2	9	8	7	6	6	5	5	4	4	3	2	1	1

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

PRODUCT ANALYSIS INFORMATION
Feed Material Rating - Hard
(Missouri Rogers Series)

CUMULATIVE PERCENT PASSING

Product Size Inches	Jaw Crusher Discharge Setting -- Inches												
	1.5	2	2.5	3	3.5	4	4.5	5	6	7	8	9	10
17													100
16												100	94
15											100	92	88
14											95	86	82
13										100	88	80	76
12									100	95	83	75	71
11									99	88	78	70	67
10								100	94	82	73	66	60
9							100	98	88	76	68	61	55
8						100	98	93	80	70	61	55	50
7					100	99	91	83	72	62	54	48	44
6				100	98	90	80	74	63	54	48	42	38
5			100	96	87	78	72	64	54	47	41	36	32
4.5			98	90	80	71	64	60	50	43	37	34	30
4			95	84	74	65	59	54	46	40	34	30	27
3.5		100	87	76	66	58	53	48	41	35	30	26	24
3	100	93	78	67	58	52	46	43	36	31	27	24	20
2.5	96	82	68	58	50	45	40	37	32	27	23	20	18
2	87	69	57	49	43	38	36	31	27	23	20	17	14
1.75	80	62	52	44	38	34	31	28	24	20	18	15	13
1.5	71	55	45	39	34	30	27	24	21	18	15	13	11
1.25	62	48	40	34	30	27	23	22	18	16	13	11	10
1	52	40	34	28	25	22	20	18	16	13	11	10	8
3/4	39	30	26	22	19	17	15	14	12	10	8	7	6
1/2	30	23	19	16	15	13	12	11	9	8	6	5	5
3/8	22	18	15	13	11	10	10	8	7	6	5	4	4
1/4	17	13	11	10	9	8	7	6	5	4	4	3	3
4M	13	10	8	7	7	6	5	5	4	3	3	2	2
8M	7	6	5	4	4	3	3	3	2	2	2	1	1

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

PRODUCT ANALYSIS INFORMATION

Feed Material Rating - Hard
(Missouri Rogers Series)

CUMULATIVE PERCENT PASSING

Product Size Milli-meters	Jaw Crusher Discharge Setting -- Millimeters												
	38	51	64	76	89	102	114	127	152	178	203	229	254
432													100
406												100	94
381											100	92	88
356											95	86	82
330										100	88	80	76
305									100	95	83	75	71
279									99	88	78	70	67
254								100	94	82	73	66	60
229							100	98	88	76	68	61	55
203						100	98	93	80	70	61	55	50
179					100	99	91	83	72	62	54	48	44
152				100	98	90	80	74	63	54	48	42	38
127			100	96	87	78	72	64	54	47	41	36	32
114			98	90	80	71	64	60	50	43	37	34	30
102			95	84	74	65	59	54	46	40	34	30	27
89		100	87	76	66	58	53	48	41	35	30	26	24
76	100	93	78	67	58	52	46	43	36	31	27	24	20
64	96	82	68	58	50	45	40	37	32	27	23	20	18
51	87	69	57	49	43	38	36	31	27	23	20	17	14
44	80	62	52	44	38	34	31	28	24	20	18	15	13
38	71	55	45	39	34	30	27	24	21	18	15	13	11
32	62	48	40	34	30	27	23	22	18	16	13	11	10
25	52	40	34	28	25	22	20	18	16	13	11	10	8
19	39	30	26	22	19	17	15	14	12	10	8	7	6
13	30	23	19	16	15	13	12	11	9	8	6	5	5
9	22	18	15	13	11	10	10	8	7	6	5	4	4
6	17	13	11	10	9	8	7	6	5	4	4	3	3
5	13	10	8	7	7	6	5	5	4	3	3	2	2
2	7	6	5	4	4	3	3	3	2	2	2	1	1

The above figures are based on results obtained in actual practice and could vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, and fracture characteristics of the feed. The indicated topsize, which is also influenced by the above conditions, is provided to assist in the selection of the crushing equipment to follow.

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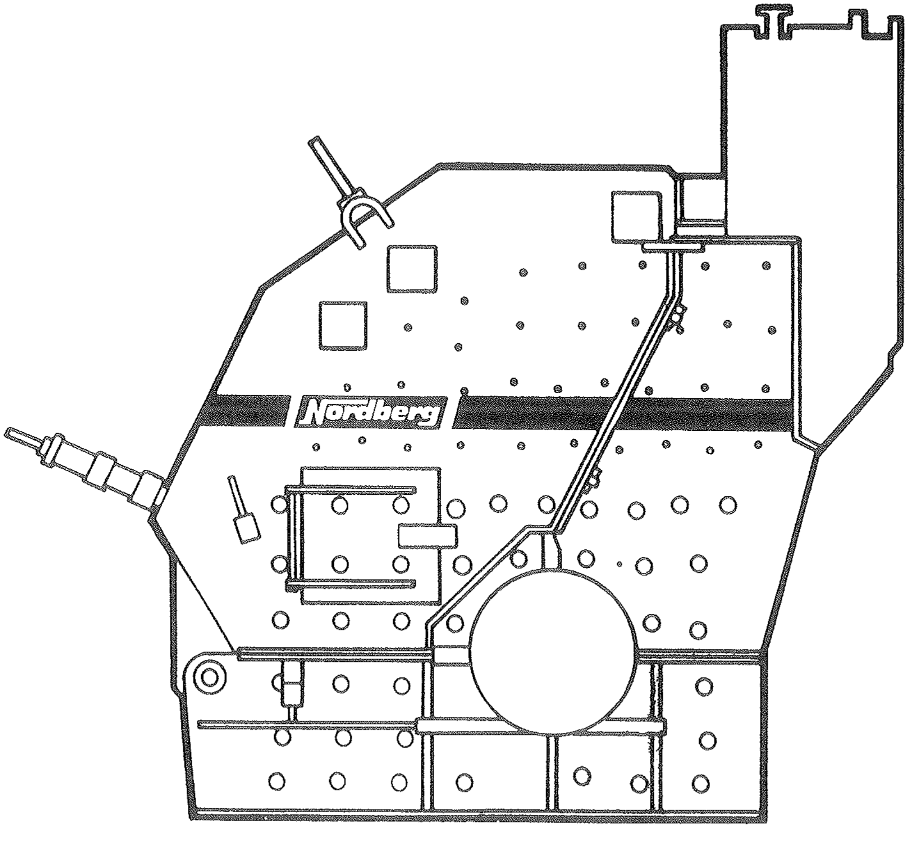
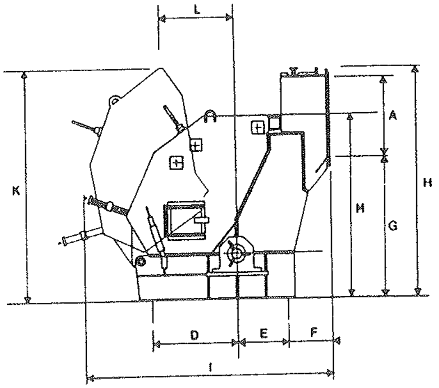
HS Impact Crushers

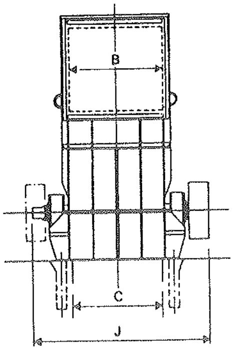


HS IMPACT CRUSHERS

CLEARANCE DIMENSIONS

	HS1310 INCHES (MM)	HSR1315 INCHES (MM)	HS1415 INCHES (MM)	HS1620 INCHES (MM)
A	47 (1175)	43 (1090)	47 (1175)	70 (1750)
B	41 (1020)	60 (1530)	60 (1530)	82 (2040)
C	41 (1020)	60 (1530)	60 (1530)	82 (2040)
D	52 (1305)	40 (1005)	52 (1305)	64 (1600)
E	31 (785)	28 (704)	31 (785)	37 (935)
F	39 (985)	37 (940)	39 (985)	35 (865)
G	86 (2165)	71 (1815)	86 (2165)	102 (2550)
H	137 (3480)	118 (3010)	137 (3480)	180 (4500)
I	149 (3780)	140 (3550)	149 (3780)	164 (4100)
J	91 (2320)	110 (2790)	118 (2980)	169 (4280)
K	136 (3460)	117 (2966)	136 (3460)	180 (4520)
L	62 (1570)	30 (748)	62 (1570)	66 (1650)
M	110 (2790)	90 (2290)	110 (2790)	146 (3705)





WEIGHTS

	HS1310 lbs (kg)	HSR1315 lbs (kg)	HS1415 lbs (kg)	HS1620 lbs (kg)
Crusher Complete	32,000 (14,515)	30,300 (13,744)	47,660 (21,618)	108,000 (48,988)
Rotor	11,000 (4,989)	10,400 (4,717)	17,000 (7,711)	30,235 (13,714)
Hammer	687 (312)	660 (299)	1,030 (467)	1,452 (659)
wr^2	23,000 lb. ft^2	24,000 lb. ft^2	33,000 lb. ft^2	75,020 lb. ft^2

HS IMPACT CRUSHER CAPACITIES

SHORT TONS (METRIC TOMS)

Crusher Capacities

Open Circuit Capacities in tons (2,000 lbs.) per hour at 100 lbs. per cu. ft.				
Setting of Lower Breaker Plate (inches from the outer most portion of the rotor circle)				
Setting Inch (mm)	Model			
	HS1310	HSR1315	HS1415	HS1620
1" (25)	150 - 180 (136-164)	210 - 240 (191-218)	300 - 340 (272-308)	550 - 750 (499-680)
2" (51)	160 - 190 (145-172)	220 - 250 (204-227)	300 - 360 (272-327)	600 - 800 (544-726)
3" (76)	180 - 210 (164-191)	240 - 270 (218-245)	340 - 380 (308-345)	650 - 850 (590-771)
4" (102)	190 - 220 (172-200)	250 - 280 (227-254)	360 - 400 (327-363)	700 - 950 (635-862)
5" (127)	195 - 225 (177-204)	260 - 300 (236-272)	365 - 405 (331-367)	800 - 1100 (726-998)
8" (203)	200 - 230 (181-209)	--- ---	380 - 420 (345-381)	900 - 1200 (816-1089)

Maximum Aggregate Top Size and Concrete Rubble Size

Model	Setting of Lower Breaker Plate - Inch (mm)											
	1" (25)		2" (51)		3" (76)		4" (102)		5" (127)		8" (203)	
	Aggregate	Rubble	Aggregate	Rubble	Aggregate	Rubble	Aggregate	Rubble	Aggregate	Rubble	Aggregate	Rubble
HS1310	7" (178)	-- --	12" (305)	24" (610)	18" (457)	36" (914)	26" (660)	36" (660)	28" (711)	36" (660)	32"(1) (813)	48" (1219)
HSR1315	7" (178)	-- --	12" (305)	24" (610)	16" (406)	24" (610)	16" (406)	24" (610)	16" (406)	24" (610)	-- --	-- --
HS1415	7" (178)	-- --	12" (305)	24" (610)	18" (457)	36" (914)	26" (660)	36" (914)	28" (711)	36" (914)	32"(1) (813)	48" (1219)
HS1620	7" (178)	-- --	12" (305)	24" (610)	18" (457)	36" (914)	26" (660)	36" (914)	36" (914)	48" (1219)	42"(2) (1067)	48"(3) (1219)

(1) This is the recommended Top Size for medium hard limestone; however, a 36" piece will fit into the explosion chamber.

(2) This is the recommended Top Size for medium hard limestone; however, a 47" piece will fit into the explosion chamber.

(3) This is the recommended dimension for concrete rubble; however, under extreme conditions an occasional 54" piece could be tolerated.

The phrase "top size is 24 inches",, means that the maximum dimension of the rock is 24" on one of its three dimensions and the other two dimensions are less than 24 inches.

See notes on the bottom of page 4-3

HS IMPACT CRUSHER PRODUCT ANALYSIS

CUMULATIVE PERCENT PASSING

Rock Size		Setting of the Lower Breaker Plate (inches from the outer most portion of the rotor circle)						
In.	(mm)	3/4" (19)	1" (25)	2" (51)	3" (76)	4" (102)	5" (127)	8" (203)
10"	(254)						100	100
9"	(229)					100	98 - 100	99 - 100
8"	(203)				100	99 - 100	92 - 100	92 - 99
6"	(152)			100	98 - 100	96 - 100	83 - 97	88 - 95
4"	(102)		100	99 - 100	94 - 98	80 - 98	72 - 85	65 -- 75
3"	(76)		99 - 100	96 - 99	78 - 90	58 - 82	55 - 76	44 - 55
2.5"	(63)	100	97 - 100	89 - 93	51 - 84	44 - 75	40 - 66	37 - 45
2"	(57)	98 - 100	94 - 100	68 - 90	40 - 78	36 - 64	36 - 52	34 - 38
1.5"	(51)	94 - 100	86 - 97	44 - 82	32 - 64	26 - 52	28 - 41	23 - 31
1"	(44)	85 - 95	68 - 90	31 - 64	25 - 47	20 - 39	21 - 33	18 - 23
0.75"	(37)	68 - 90	55 - 80	22 - 56	20 - 38	17 - 32	18 - 25	14 - 19
0.5"	(31)	54 - 78	44 - 67	15 - 38	16 - 29	13 - 24	12 - 20	11 - 15
0.37"	(25)	43 - 63	35 - 51	11 - 32	13 - 24	10 - 19	10 - 14	9 - 12
0.25"	(22)	36 - 47	27 - 40	9 - 24	10 - 19	8 - 15	7 - 9	5 - 10
4M	(19)	27 - 38	22 - 31	8 - 18	8 - 16	6 - 12	5 - 8	5 - 8
6M	(16)	23 - 30	18 - 24	6 - 16	6 - 12	4 - 10	4 - 7	4 - 6
8M	(12)	18 - 28	15 - 19	4 - 12	4 - 10	3 - 8	3 - 5	3 - 5
10M	(9)	12 - 18	10 - 15	3 - 10	3 - 8	3 - 6	3 - 4	3 - 4
48M	(6)	4 - 2	3 - 7	1 - 5	1 - 3	≤ 2	≤ 2	≤ 2
200M	(5)	≤ 3	≤ 3	≤ 2	≤ 2	≤ 2	≤ 1	≤ 1

Horizontal Shaft Impact Crusher Charts:
The capacity charts are developed for use as an application tool to properly utilize the capabilities of the Nordberg HS Impact Crusher. The crusher is one component of the circuit. As such, their performance is in part dependent on the proper selection and operation of feeders, conveyors, screens, supporting structure, electric motors, drive components, and surge bins. Where used attention to the following factors will enhance crusher capacity and performance.

i Proper selection of the wear component metallurgy.
ii Proper rotor speed.
iii Proper breaker plate positioning.
iv Proper feed distribution (rule-of-thumb: the feeder should have a width of at least 75% of rotor width).

The following factors will detract from crusher capacity and performance.

i Sticky material in crusher feed.
ii Fines in crusher feed (fines are those particles which could become airborne).
iii Excessive feed moisture.
iv Improper feed distribution (see "rule-of-thumb" above).
v Extremely hard or tough material.

The capacities and gradations shown in the tables are averages based on results obtained from installations worldwide, crushing the broadest range of ores, rocks and minerals. To determine effect of individual conditions, consult Nordberg.

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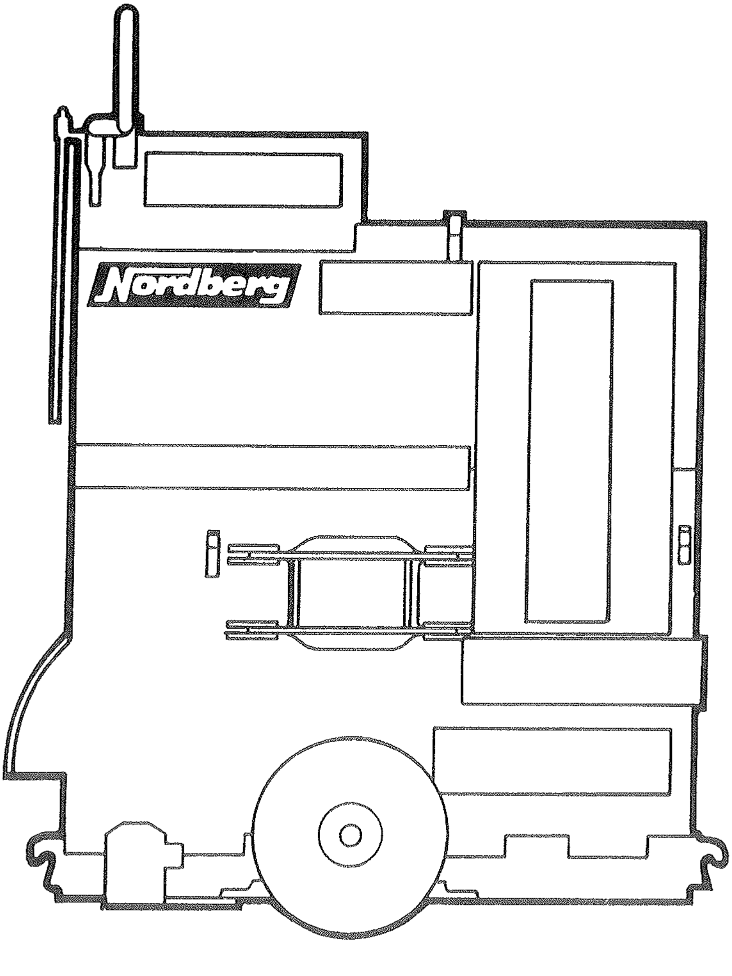
IMPACT CRUSHERS 4-4

Missouri Rogers Impact Crushers



IMPACT CRUSHERS
(Missouri Rogers)

MODEL NUMBER	3445	3850	4654	5660
Actual Feed Opening				
Width	34"/860mm	38"/961mm	46"/1170mm	56"/1420mm
Height	56"/1420mm	63"/1600mm	71"/1800mm	92"/2340mm
Rotor (Cast Alloy Steel with 2.25% Nickel)				
Diameter	36"/915mm	36"/915mm	42"/1070mm	48"/1220mm
Length	33.75"/860mm	38.5"/980mm	45.5"/1155mm	56"/1420mm
Weight	6300#/2860kg	7950#/3600kg	13,000#/5900kg	20,300#/9200kg
$WK^2(LBFT^2)$	8400	12,000	24,000	32,000
Hammers				
Weight	255# Ea/115kg	362# Ea/165kg	560# Ea/250kg	875# Ea/400kg
Projection Above Rotor	4"/102mm	4"/102mm	5"/127mm	5.5"/140mm
Shaft				
Dia in Rotor	6.375"/160mm	8"/200mm	8.5"/215mm	10"/254mm
Dia in Bearings	5.12"/130mm	6.69"/170mm	7.48"/190mm	8.66"/220mm
Weight	667#/300kg	970#/440kg	1326#/600mm	2110#/960kg
Breaker Bars-Dia/Weight				
Feed Box	5"/130mm @217#/100kg	5"/130mm @241#/110kg	6"/150mm @417#/190kg	6"/150mm @513#/232kg
Top	NA	NA	NA	6"/150mm @513#/232kg
Upper	5"/130mm @252#/115kg	5"/130mm @276#/125kg	6"/150mm @450#/205kg	8"/200mm @1026#/465kg
Lower	5"/130mm @252#/115kg	5"/130mm @276#/125kg	6"/150mm @481#/219kg	6"/150mm @577#/260kg
Stripper	3.5"/90mm @136#/60kg	3.5"/90mm @145#/65kg	3.5"/90mm @161#/73kg	4"/100mm @257#/116kg
Breaker Bar Sleeves-Standard	4 @ 8"/200mm	4 @ 8"/200mm	5 @ 9"/230mm	3 @ 9"/230mm 3 @ 11.5"/300mm

IMPACT CRUSHERS
(Missouri Rogers)
(Continued)

MODEL NUMBER	3445	3850	4654	5660
Sleeves - Dia/Weight Each				
8" Dia	230#/105kg	290#/130kg	221#/100kg	NA
9" Dia	NA	NA	384#/175kg	474#/215kg
10" Dia	360#/165kg	435#/200kg	NA	NA
11" Dia	NA	NA	554#/250kg	NA
11.5" Dia	NA	NA	NA	682#/310kg
13" Dia	NA	NA	NA	918#/415kg
17" Dia	NA	NA	NA	1850#/840kg
Explosion Chamber				
Cubic Ft	118	139	228	400
Steel Plate	1"/25mm	1"/25mm	1.25"/32mm	1.5"/38mm
Liners				
Bottom Front	.75"/19mm	.75"/19mm	.75"/19mm	.75"/19mm
Side	.625"/16mm	.625"/16mm	.625"/16mm	.75"/19mm
Bottom Rear	.375"/10mm	.375"/10mm	.5"/13mm	.5"/13mm
Access Doors	24"/610mm Length x 21.75"/540mm Height	24"/610mm Length x 21.75"/540m m Height	24"/610mm Length x 21.75"/540mm Height	24"/610mm Length x 21.75"/540mm Height
Crusher Weight	35,000# 15,875kg	40,000# 18,145kg	55,000# 24,950kg	96,000# 43,545kg
Rate TPH	150/400	250/500	400/800	600/1200
R.P.M.	450/860	470/725	400/650	350/600
Electric Motor HP	150/250	150/300	250/400	300/600

IMPACT CRUSHER CAPACITIES
(Missouri Rogers)
SHORT TONS (METRIC TOMS)

Setting Inch (mm)	Crusher Size			
	3445 @ 700 RPM	3850 @ 700 RPM	4854 @ 600 RPM	5660 @ 500 RPM
2 (51)	200 (181)	300 (272)	400 (363)	600 (544)
2-1/2 (64)	250 (227)	350 (318)	460 (417)	700 (635)
3 (76)	290 (263)	400 (363)	550 (499)	800 (726)
3-1/2 (89)	315 (286)	450 (408)	625 (567)	900 (816)
4 (102)	350 (318)	500 (453)	700 (635)	1000 (907)
4-1/2 (114)		550 (499)	770 (699)	1100 (998)
5 (127)		600 (544)	850 (771)	1200 (1088)
5-1/2 (139)			925 (839)	1300 (1179)
6 (152)			1000 (907)	1400 (1270)

The above chart shows typical tonnages that can be handled by various size Missouri Rogers impact crushers operating at different settings. Since materials and conditions can differ widely, tonnages shown are approximate only.

Capacities shown are based on feed having an average run of quarry analysis on friable medium hard limestone weighing 100 lbs. per cubic foot crushed (1602 kg per cubic meter) of a size which will readily enter the crushing chamber without bridging.

Capacities shown may vary depending on the type of material, gradation of feed, method of feeding, moisture and clay content, bulk density and fracture characteristics of the feed. Undersize material should be removed from crusher feed to eliminate packing and excessive wear.

IMPACT CRUSHER PRODUCT ANALYSIS

(Missouri Rogers)

CUMULATIVE PERCENT PASSING

Size		Crusher Setting in Inches (mm)									
In.	(mm)	2" (51)	3" (76)	4" (102)	5" (127)	6" (152)	2" (51)	3" (76)	4" (102)	5" (127)	6" (152)
10"	(254)					97				95	90
9"	(229)				98	93			98	93	87
8"	(203)				95	89			95	90	82
7"	(179)			98	91	84		98	91	84	77
6"	(152)			93	85	79		95	86	79	71
5"	(127)		96	87	79	75	98	90	73	60	64
4"	(102)		90	80	72	68	95	72	65	59	57
3.5"	(88)	98	85	75	68	64	92	71	51	55	53
3"	(76)	93	80	70	63	58	87	70	61	54	50
2.75"	(70)	90	76	67	60	55	83	67	58	52	47
2.5"	(63)	87	73	64	57	53	79	64	55	50	45
2.25"	(57)	83	69	61	54	50	77	61	53	47	42
2"	(51)	79	65	58	51	47	74	58	50	44	39
1.75"	(44)	74	61	54	48	44	68	54	46	41	36
1.5"	(37)	70	56	50	44	40	64	50	43	37	33
1.25"	(31)	64	51	45	40	36	57	45	38	33	29
1"	(25)	58	45	40	35	32	50	40	34	28	25
.875"	(22)	54	42	37	33	29	47	37	31	26	23
.75"	(19)	50	40	34	30	26	43	33	26	23	20
.625"	(16)	45	35	31	27	23	38	29	24	19	18
.5"	(12)	40	31	27	24	20	34	25	20	16	15
.375"	(9)	34	26	22	19	16	28	20	16	14	12
.25"	(6)	26	20	16	15	12	20	15	12	10	8
4M	(5)	21	16	13	11	9	16	12	9	8	6
8M	(2)	11	9	8	7	6	9	7	6	5	4

Crusher Size and R.P.M.	3445 @ 600 R.P.M. 3850 @ 600 R.P.M.	3445 @ 450 R.P.M. 3850 @ 500 R.P.M. 4654 @ 550 R.P.M.

The results shown above indicate an average analysis of stone crushed by a single-rotor, two-hammer crusher working in dry, free crushing medium hard limestone. No guarantee of product sizing can be inferred, since stone varies from area to area along with other local conditions. These are typical gradations for the speeds shown. Coarser or finer grading can be achieved by making speed changes. Consult Nordberg for specific recommendations.

IMPACT CRUSHER PRODUCT ANALYSIS
(Missouri Rogers)
(Continued)

CUMULATIVE PERCENT PASSING

Size		Crusher Setting in Inches (mm)									
In.	(mm)	2" (51)	3" (76)	4" (102)	5" (127)	6" (152)	2" (51)	3" (76)	4" (102)	5" (127)	6" (152)
10"	(254)			98	90	81			95	85	75
9"	(229)			95	85	76			91	79	69
8"	(203)			90	79	71		99	85	72	62
7"	(179)		97	81	73	65		93	76	64	56
6"	(152)		90	76	66	60		85	67	56	50
5"	(127)	98	80	68	60	54	95	71	59	50	45
4"	(102)	90	71	60	54	48	85	62	50	44	40
3.5"	(88)	83	65	55	50	44	73	55	46	41	37
3"	(76)	76	60	52	47	41	64	50	42	38	34
2.75"	(70)	72	57	49	44	39	61	47	40	35	32
2.5"	(63)	68	54	47	41	37	57	45	38	33	30
2.25"	(57)	64	52	44	39	35	53	42	36	31	28
2"	(51)	60	49	41	37	33	50	39	33	29	26
1.75"	(44)	55	46	38	34	30	46	36	30	26	23
1.5"	(37)	51	42	35	31	27	42	33	27	23	20
1.25"	(31)	46	38	32	27	24	36	30	24	20	17
1"	(25)	41	33	28	24	21	31	25	20	17	14
.875"	(22)	38	30	25	22	20	28	23	18	15	12
.75"	(19)	35	27	23	20	18	25	20	16	13	10
.625"	(16)	32	24	20	17	16	23	17	13	11	9
.5"	(12)	27	21	17	14	11	18	14	10	9	6
.375"	(9)	22	17	13	11	9	15	11	8	7	4
.25"	(6)	16	12	9	8	7	10	7	5	4	3
4M	(5)	12	8	7	6	5	7	5	4	3	2
8M	(2)	7	5	4	4	3	4	3	3	2	1

Crusher Size and R.P.M.	3850 @ 400 R.P.M. 4654 @ 450 R.P.M. 5660 @ 450 R.P.M.	4654 @ 350 R.P.M. 5660 @ 350 R.P.M.

The results shown above indicate an average analysis of stone crushed by a single-rotor, two-hammer crusher working in dry, free crushing medium hard limestone. No guarantee of product sizing can be inferred, since stone varies from area to area along with other local conditions. These are typical gradations for the speeds shown. Coarser or finer grading can be achieved by making speed changes. Consult Nordberg for specific recommendations.

Nordberg®

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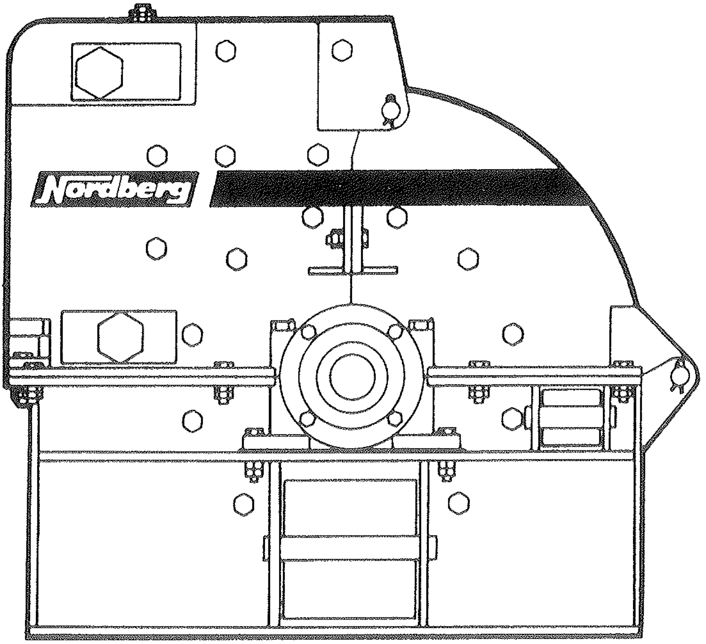
Hammermill Crushers



HAMMERMILLS

SIZES-HORSEPOWER-SPEED-WEIGHT-FEED OPENING-CAPACITIES

MILL SIZE	ELECTRIC H.P.	MILL R.P.M.	APPROX. WEIGHT	FEED OPENING
3036	150-250	900-1600	12,500 Lbs. 5900 kg.	8" x 36" 205 x 915 mm
3440	150-250	600-1200	12,950 Lbs. 5900 kg.	15" x 42" 380 x 1070 mm
4854	250-500	600-800	25,700 Lbs. 11,600 kg.	25" x 58" 635 x 1475 mm

APPROXIMATE HAMMERMILL CAPACITIES								
MILL SIZE	AG. LIME	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	3/4" (19mm)	1" (25mm)	1-1/2" (38mm)	2" (50mm)
3036	60	70	80	90	110	130	160	190
3440	40-65	45-85	55-90	65-95	85-125	105-145	145-185	165-205
4854				125-185	150-200	190-270	270-350	320-400

All capacities based on dry, free crushing material weighing 100 lbs./ft³ broken. Motor horsepower will vary with speed, capacity and product size. Capacities are for closed circuit operation with a screen of adequate size.

HAMMERMILL PRODUCT ANALYSIS CHART
OPEN CIRCUIT

These charts give an average analysis of stone crushed in a hammermill in relation to the opening in the grates. Sizes 3/8" and below relate to higher speeds of approximately 1200 to 1600 R.P.M., and sizes 1/2" and above to slower speeds of 600 to 900 R.P.M. where fines are to be minimized.

PERCENT PASSING EACH SIZE IN PRODUCT OF CRUSHER

SIZE		GRATE SIZE							
(In.)	(mm)	3/16" (5mm)	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	1" (25mm)	1-1/2" (38mm)
-1-1/2"	-38								100
-1"	-25							100	95
-3/4"	-19						100	97	90
-5/8"	-16					100	97	92	84
-1/2"	-13				100	96	92	86	75
-3/8"	-10		100	100	96	91	85	71	61
-1/4"	-6	100	99	96	91	81	71	57	45
-3/16"	-5	99	95	91	85	71	60	48	37
-10M		86	81	67	59	48	37	31	25
-20M		59	64	50	44	37	27	21	16
-40M		50	47	36	30	25	19	15	11
-100M		29	27	20	16	13	11	9	7

It is standard practice, particularly in mills with fine grates, to include one or more "Clean Out" grates. This reduces overgrinding and consequently excessive wear without materially affecting the product analysis, except that a small percentage over the top size shown may be present.

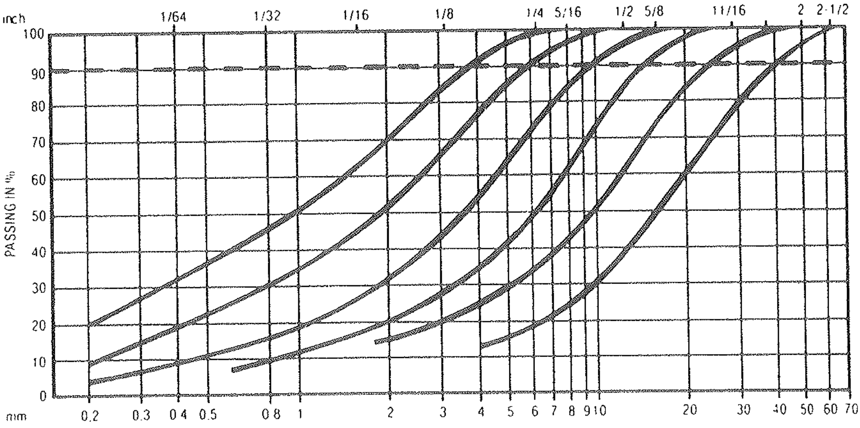
Use 1-1/2" grate size column for hammermills with wide-open grates or no grates.

HAMMERMILLS

SIZES - HORSEPOWER - SPEED - WEIGHT - FEED OPENING - CAPACITIES

Machine Size	Rotor Size Dia. x L	Electric H.P.	Mill RPM Max.	Approx Weight	Feed Opening	Max. feed Size	Approx. Hammermill Capacities			
							1mm 3/64 in	3mm 1/8 in	10mm 3/8 in	15mm 5/8 in
BM 80x40	840 x 400 mm	20-30	1200	2,700 Kgs.	365 x 420 mm	100-120 mm	2-3 MTPH	5-8 MTPH	12-18 MTPH	15-22 MTPH
	33.06x15.75 in.			5,950 Lbs.	14.38x16.56 in.	4-5 in.	2-3 STPH	6-9 STPH	13-20 STPH	17-24 STPH
BM 100x65	1000 x 650 mm	60-75	1000	6,000 Kgs.	630 - 730 mm	150-200 mm	5-8 MTPH	12-20 MTPH	25-40 MTPH	35-50 MTPH
	39.38x25.63 in.			13,230 Lbs.	24.81x28.75 in.	6-8 in.	6-9 STPH	13-22 STPH	28-44 STPH	39-55 STPH
BM 100x100	1000 x 1000 mm	100-120	1000	8,200 Kgs.	630 x 1010 mm	180-250 mm	8-12 MTPH	20-30 MTPH	40-60 MTPH	50-75 MTPH
	39.38x39.38 in.			18,080 Lbs.	24.81x39.25 in.	7-10 in.	9-13 STPH	22-33 STPH	44-66 STPH	55-83 STPH
BM 100x125	1000 x 1250 mm	120-150	1000	9,100 Kgs.	630 - 1220 mm	180-250 mm	10-16 MTPH	25-40 MTPH	50-80 MTPH	65-100 MTPH
	39.38x49.25 in.			20,060 Lbs.	24.81x48 in.	7-10 in.	11-18 STPH	28-44 STPH	55-88 STPH	72-110 STPH

GENERAL PRODUCT ANALYSIS



This chart gives an average analysis of stone crushed by a single rotor; it is based on dry, free crushing, medium-hard limestone. It does not imply any guarantee or product sizing, since all stone varies from area and local conditions are never the same.

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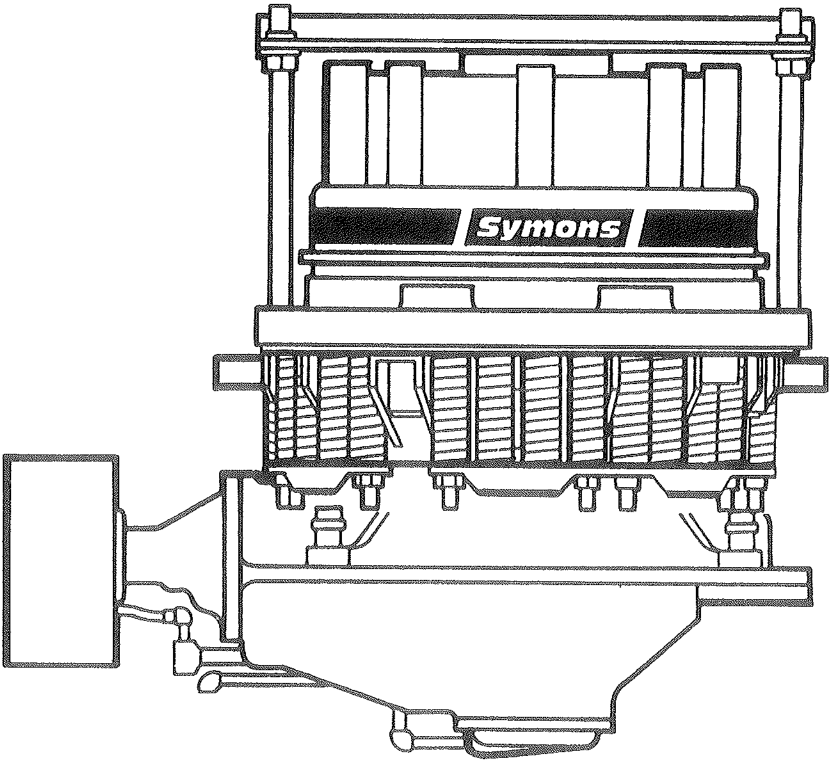
Symons Cone Crushers



STANDARD SYMONS CONE CRUSHER APPLICATION INFORMATION

The Symons Standard cone crusher is normally applied as a secondary crusher in plants designed for three or four stages of crushing. However, the wide range of crushing cavities available in the Standard cone crusher permits its installation as a primary crusher in many cases. The feed openings available range from over 18" in the 7 Ft. crusher size to 4" in the 2 Ft. Standard. The Standard cone usually operates in an open circuit, preparing feed for the finishing crushing stages where Short Head cones and Gyradisc crushers are employed. The normal operating range for the Standard cone is to make a crushed product ranging from approximately 3/4" to 3" or 4". It is considered sound crushing practice to effect a reduction ratio of 6 or 8:1 when operating in open circuit. Standard cones may also be operated in a closed circuit in large or small operations where a single reduction is required. Because of the wide range of cavities available feed sizes up to 12" can be reduced in some cases to all passing 3/4" in a properly designed closed circuit.

Standard cone crushers are built in seven sizes with crushing heads from two to ten feet in diameter. Capacities in open circuit range from 18 to over 3000 tph depending on the characteristics of the material being crushed, crusher size and setting, and crushing cavity design.

Operating Recommendations

The feed to the Standard cone is normally scalped if over 25 percent of the desired crusher product is present in the new feed. Since the range of feed size will often vary from approximately 12" to 2" in a given installation the crushing cavity must be selected to reduce these sizes efficiently. Where the topsize of the feed is only 8" the crushing cavity would be modified to reflect this smaller feed size. To meet these variations in size of feed and desired product size Standard cones can be equipped with various designs of fine, medium, coarse, or extra coarse crushing cavities.

In selecting the crushing cavity care is taken to obtain a design that will permit the topsize of the feed to enter the crusher in sufficient volume throughout the entire wear life of the liners. Since the most efficient crushing action takes place when the feed is reduced in a series of 4 or 5 blows as it passes through the cavity, it becomes important to select a design that will effect some reduction in the upper portion of the cavity as well as the lower or parallel sizing zone. In other words, too large an opening for the feed will prevent crushing in the upper zones and can develop excessive power draw. Since the crusher feed rate is governed by the power draw, an incorrect cavity can reduce the crusher capacity and, on occasion, create unnecessary maintenance. On the other hand, if the cavity will only accept the feed when the liners are new but as the liners wear the feed opening closes off reducing the feed rate, a more efficient cavity is required. Since no two ores or crushing applications are exactly the same, a large number of cavity designs have become available through the years. Therefore, the optimum in cavity design is one which permits close to the rated power draw throughout the entire wear life and results in a scrap loss between 25 and 40 percent.

With the proper cavity design, maximum efficiency will be obtained if the feed is evenly distributed around the entire crushing cavity. Normally, the wide feed size range required in the Standard or secondary crushing stage is such that the crushing cavity is required to have a receiving opening considerably larger than the average portion of the feed. For best results the feed should be regulated based on the crusher motor power draw. When handling the harder materials it is likely the crushing cavity in the Standard cone crusher will not be entirely filled up or "choked". However, maximum capacity will be obtained under these conditions when cavity design and proper feed distribution methods are observed.

SHORT HEAD SYMONS CONE CRUSHER APPLICATION INFORMATION

The Short Head cone crusher is normally applied as a third stage crusher.in plants designed for three or tour stages of crushing. However, the wide range of crushing cavities available in the Short Head cone crusher permits its installation as a secondary crusher in many cases. The normal operating range for the Short Head cone crusher is to make a crushed product ranging from l/8" to 1" in closed circuit. It is considered sound crushing practice to effect a reduction ratio of approximately 4 or 6:1 in the Short Head crusher stage. Short Head cones may also be operated in open circuit where unusual screening and plant design conditions exist. Where extremely fine products are required, the Short Head cone prepares the feed for the Gyradisc crusher circuit where product sizes as fine as 20 mesh are produced.

Operating Recommendations

The feed to Short Head cone crusher is normally screened to remove the finished product sizes and to provide void space for the crushed particles produced in the cavity. Maximum production will be obtained when the crusher operates at or near full load continuously. To achieve this condition, plant design feed distribution and the type of crushing cavity are factors which warrant considerations. The schematic arrangement shown in Figure A permits the crusher to operate with a controlled feed rate. The circuit shown in Figure A offers the optimum in crusher feed control and automation. The new feed is withdrawn from the bin directly to the crusher, assuring a steady controllable feed rate. In a properly fed crushing cavity the material is distributed in a manner which utilizes the entire circumferential area of the receiving opening. It is equally important to have the finer gradations in the feed interspersed with the coarse feed.

To meet variations in feed size and produce requirements, the Short Head cone can be equipped with various designs of fine, medium, coarse, and extra coarse crushing cavities.

In selecting the crushing cavity care is taken to obtain a design that will permit the topsize of the feed to enter the crusher in sufficient volume throughout the entire wear life of the liners. Since

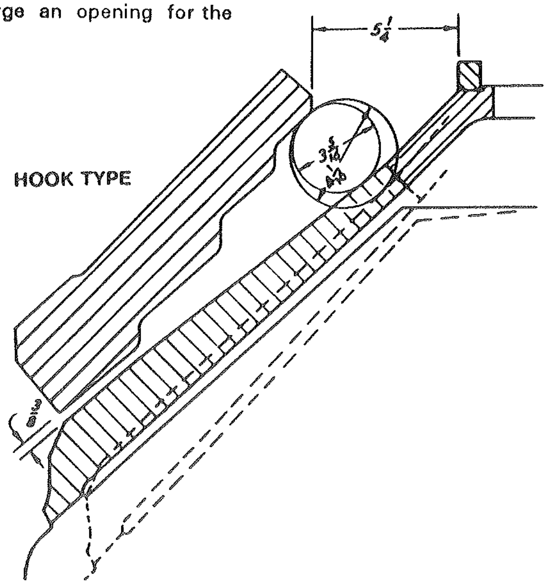
the most efficient crushing action takes place when the feed is reduced in a series of 4 or 5 blows as it passes through the cavity, it becomes important to select a design that will effect some reduction in the upper portion of the cavity as well as the lower or parallel sizing zone. In other words, too large an opening for the feed will prevent crushing in the upper zones and can develop excessive power draw. Since the crusher feed rate is governed by the power draw, an incorrect cavity can reduce the crusher capacity and, on occasion, create unnecessary maintenance. On the other hand, if the cavity will only accept the feed when the liners are new but as the liners wear the feed opening closes off reducing the feed rate a more efficient cavity is required. Since no two crushing applications are exactly the same, a large number of cavity designs have become available through the years. Therefore, the optimum in cavity design is one which permits close to the rated power draw throughout the entire wear life and results in a scrap loss between 25 and 40 percent.

When the feed material is relatively non-abrasive, the crushing cavity selection is usually made to permit a condition where the entire cavity is filled up or "choked". A certain degree of self-regulation takes place under these conditions.

When crushing a material which is both hard and abrasive, it is possible that the full motor power can be drawn without having the crushing cavity entirely filled or "choked". As the crusher liners wear, the condition will develop where a "choked" cavity can be observed.

CRUSHER LINER SELECTION

In selecting the crushing cavity care is taken to obtain a design that will permit the top size of the feed to enter the crusher in sufficient volume throughout the entire wear life of the liners. Since the most efficient crushing action takes place when the feed is reduced in a series of 4 or 5 blows as it passes through the cavity, it becomes important to select a design that will effect some reduction in the upper portion of the cavity as well as the lower or parallel sizing zone. In other words, too large an opening for the feed will prevent crushing in the upper zones and can develop excessive power draw. Since the crusher feed rate is governed by the power draw, an incorrect cavity can reduce the crusher capacity and, on occasion, create unnecessary maintenance. On the other hand, if the cavity will only accept the feed when the liners are new but as the liners wear the feed opening closes off reducing the feed rate, a more efficient cavity is required. Since no two ores or crushing



applications are exactly the same, a large number of cavity designs have become available through the years. Therefore, the optimum in cavity design is one which permits close to the rated power draw throughout the entire wear life and results in a scrap loss between 25 and 40 percent. Frequently, where crushing plants are not meeting rated capacity, or increased capacity is required a crushing cavity investigation is warranted.

As a guide, the initial liner selection is made based on the feed analysis, abrasiveness of the rock, and crusher product required. The feed should be generally no larger than 80 percent of the liner open side dimension shown on the cavity table. Subsequent observations of the crusher in operation will dictate the optimum design. Since crusher performance depends on proper liner design, the sheet entitled "Data Sheet For Liner Study" is useful in analyzing a specific application.

DATA SHEET FOR LINER STUDY

CUSTOMER NAME ____________ LOCATION ______________________

CRUSHER SERIAL NO. ______________________________________

CRUSHER SIZE ____

TYPE (STANDARD, SHORT HEAD, GYRADISC) ____________________

FEED SIZE ___________ PRODUCT SIZE _______________________

NORMAL POWER DRAW, AMPS __ KWH ___________________________

PRESENT BOWL LINER _____ MANTLE ___________________________

FEED RATE (PLANT DESIGN) _________________________________

OPEN OR CLOSED CIRCUIT __________________________________

TOTAL TONNAGE CRUSHED PER SET OF LINERS _________________

TONNAGE THROUGH CRUSHER WITH NEW LINERS _________________

1/3 WORN " ________________

1/2 WORN " ________________

2/3 WORN " ________________

FULL SIZE CONTOUR FROM WORN CROSS-SECTION OF BOWL LINER AND MANTLE

TRACED ON PAPER OR CARDBOARD _____________________________

COMMENTS: ____

____

____

SYMONS CONE CRUSHERS
FEED MATERIAL RATING - AVERAGE

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Closed Side Setting of Crusher, Inch							
	1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
4"								100
3"							100	91
2-1/2"						100	95	82
2"					100	93	86	70
1-1/2"				100	92	80	70	51
1-1/4"				95	82	70	57	41
1"			100	86	70	54	44	32
3/4"		100	92	70	51	39	32	25
1/2"	100	86	70	44	32	26	22	17
3/8"	94	70	51	32	25	20	17	13
1/4"	70	44	32	22	17	14	12	9
3/16"	50	32	25	17	13	11	9	7
No. 6	34	23	18	12	10	8	7	5
No. 8	25	17	13	9	7	6	5	4

Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

SYMONS CONE CRUSHERS
FEED MATERIAL RATING - AVERAGE

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Millimeter	Closed Side Setting of Crusher, Millimeter							
	6mm	10mm	13mm	19mm	25mm	32mm	38mm	51mm
102mm								100
76mm							100	91
64mm						100	95	82
51mm					100	93	86	70
38mm				100	92	80	70	51
32mm				95	82	70	57	41
25mm			100	86	70	54	44	32
19mm		100	92	70	51	39	32	25
13mm	100	86	70	44	32	26	22	17
10mm	94	70	51	32	25	20	17	13
6mm	70	44	32	22	17	14	12	9
5mm	50	32	25	17	13	11	9	7
3mm	34	23	18	12	10	8	7	5
2mm	25	17	13	9	7	6	5	4

Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

SYMONS CONE CRUSHERS
FEED MATERIAL RATING - HARD

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Closed Side Setting of Crusher, Inch							
	1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
4"								100
3"							100	92
2-1/2"						100	95	79
2"					100	94	84	60
1-1/2"				100	92	76	60	40
1-1/4"				95	79	60	46	30
1"			100	84	60	43	33	22
3/4"		100	92	60	40	29	22	16
1/2"	100	84	60	33	22	17	14	11
3/8"	92	60	40	22	16	13	11	8
1/4"	60	33	22	14	11	9	7	6
3/16"	40	22	16	11	8	7	6	4
No. 6	24	15	12	8	6	5	4	3
No. 8	16	11	8	6	4	4	3	2

Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

SYMONS CONE CRUSHERS
FEED MATERIAL RATING - HARD

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Millimeter	Closed Side Setting of Crusher, Inch							
	6mm	10mm	13mm	19mm	25mm	32mm	38mm	51mm
102mm								100
76mm							100	92
64mm						100	95	79
51mm					100	94	84	60
38mm				100	92	76	60	40
32mm				95	79	60	46	30
25mm			100	84	60	43	33	22
19mm		100	92	60	40	29	22	16
13mm	100	84	60	33	22	17	14	11
10mm	92	60	40	22	16	13	11	8
6mm	60	33	22	14	11	9	7	6
5mm	40	22	16	11	8	7	6	4
3mm	24	15	12	8	6	5	4	3
2mm	16	11	8	6	4	4	3	2

Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

CONE CRUSHER CAPACITY CHARTS

Cone crusher capacity charts are developed for use as an application tool to properly utilize the machine's capabilities when operated in closed circuit. Symons cone crushers have 3 separate and distinct capacities (see diagrams on following page). The difference between these is the point in the circuit at which the measure is taken in either open circuit or closed circuit operation. The crusher is one component of the circuit. As such, its performance is in part dependent on the proper selection and operation of feeders, conveyors, screens, supporting structure, electric motors, drive components and surge bins. Where used, attention to the following factors will enhance crusher capacity and performance.

1. Proper selection of crushing chamber for material to be crushed.
2. A feed grading containing proper distribution of the particle sizes.
3. Controlled feed rate.
4. Proper feed distribution 360 degrees around the crushing chamber.
5. Discharge conveyor sized to carry maximum crusher capacity.
6. Properly sized scalping and closed circuit screens.
7. Automation controls.
8. Adequate crusher discharge area.

The following factors will detract from crusher capacity and performance.

1. Sticky material in crusher feed.
2. Fines in crusher feed (smaller than crusher setting) exceeding 10% of crusher capacity.
3. Excessive feed moisture.
4. Feed segregation in crusher cavity.
5. Improper feed distribution around circumference of crushing cavity.
6. Lack of feed control.
7. Insufficient use of recommended connected horsepower.
8. Insufficient conveyor capacity.
9. Insufficient scalper and closed circuit screen capacities.
10. Insufficient crusher discharge area.
11. Extremely hard or tough material.
12. Operation of crusher at less than recommended full load countershaft speed.

Capacities shown are neither maximum nor minimum, and are based on results secured in actual practice. The figures shown apply to short tons of material weighing 100 pounds per cubic foot, and are based on a properly graded feed.

Note: To convert short tons to metric tons, multiply short tons by .907.

The capacities shown in the tables are based on results obtained from thousands of installations worldwide, crushing the broadest range of ores, rocks and minerals to determine effect of individual conditions.

USING THE CHARTS ON THE FOLLOWING PAGES

To determine crusher capacity for proposed installation, determine whether crusher is to be operated in open circuit or closed circuit, as shown in schematic below.

For Open Circuit Operation:

A. Capacities shown in column listed under "Discharge Setting A" for the standard crusher and "Discharge Setting C" for the standard crusher lists the capacities of all size crushers for each liner combination in tons per hour passing through crusher. Recommended closed side setting for each size crusher and type of cavity is listed from left to right.

B. Using known data on proposed feed size and tonnage required, select correct size machine and proper type of crushing cavity.

Note: Capacities shown (Open Circuit Charts) can be used to assist in the proper sizing of conveyors, feeders and screens. These capacities are based on an average screen efficiency of 90%.

For closed Circuit Operation:

A. Column listed as "Note 1" shows net finished capacity at various settings of each size crusher. This is the net finished product passing the effective square opening of the screen (screen undersize).

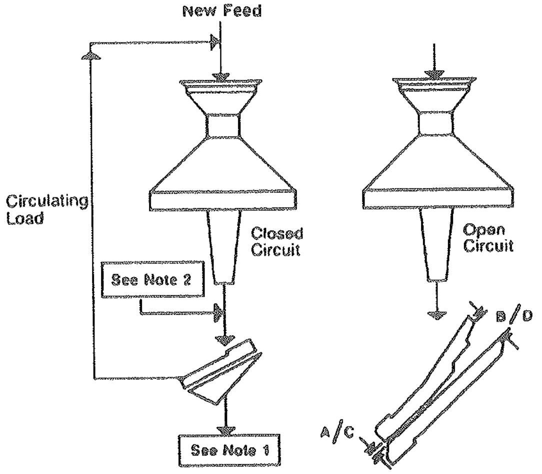
B. Column listed as "Note 2" shows total capacity at various settings of each size crusher. This is the total tons per hour passing through the crusher (net finished product plus recirculating load).

C. Using known data on proposed feed size and tonnage required, select correct size machine and proper type of crushing cavity.

Crushing Cavity Selection:

For **preliminary** selection of crushing cavity, proposed feed grading top size should pass a square opening not to exceed 90% of "D" dimension at open side.

Note: Capacities shown in column listed as "**Note 2**" are provided to assist in the proper sizing of conveyors, feeders and screens. These capacities are based on an average screen efficiency of 90%.



STANDARD SYMONS CONE CRUSHER CAPACITY CHART

STANDARD SYMONS CONE CRUSHERS - CAVITIES * FEED OPENINGS * PRODUCT SIZES * CAPACITIES

OPEN CIRCUIT - CAPACITIES IN TONS (2000 LB) PER HOUR PASSING THROUGH THE CRUSHER AT INDICATED DISCHARGE SETTING "A"															
Size	Type of Cavity	Recommended minimum discharge setting A	Feed opening with min. recommended discharge setting A		1/4" 6mm)	3/8" (9mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	7/8" (22mm)	1" (25mm)	1-1/4" (31mm)	1-1/2" (38mm)	2" (51mm)	2-1/2" (64mm)
			B Closed side	B Open side											
2 Ft.	Fine	1/4" (6mm)	2-1/4" (56mm)	2-7/8" (72mm)	18	20	25	30	35	40	45	50	60		
	Coarse	3/8" (9mm)	3-1/4" (83mm)	4-3/8" (109mm)		20	25	30	35	45	50	60	75		
(610mm)	Extra Coarse	1/2" (13mm)	4" (100mm)	4-3/8" (109mm)			25	30	40	50	55	70	80		
3 Ft.	Fine	3/8" (9mm)	3-5/16" (83mm)	4-1/16" (102mm)		50	85	80	90	100					
	Coarse	1/2" (13mm)	6-3/8" (159mm)	7" (175mm)			85	80	100	120	130	150	180		
(914mm)	Extra Coarse	1" (25mm)	6-1/2" (163mm)	7-1/8" (178mm)							130	150	180		
4 Ft.	Fine	3/8" (9mm)	5" (127mm)	5-1/4" (131mm)		70	100	120	140	155	170	185			
	Medium	1/2" (13mm)	6-1/8" (156mm)	6-1/4" (156mm)			110	130	150	160	180	200	220		
	Coarse	3/4" (19mm)	7-1/8" (178mm)	7-5/8" (191mm)					155	170	200	220	270	340	
(1219mm)	Extra Coarse	1" (25mm)	9-1/4" (231mm)	10" (250mm)							210	230	280	350	
4-1/4 Ft.	Fine	1/2" (13mm)	4-3/8" (109mm)	5-3/8" (137mm)			120	140	160	170	180	200			
	Medium	5/8" (16mm)	7-1/2" (188mm)	8-1/4" (210mm)				145	175	190	220	250	280		
	Coarse	3/4" (19mm)	8-5/8" (216mm)	9-5/8" (241mm)					190	215	240	275	325	385	
(1295mm)	Extra Coarse	1" (25mm)	9-1/2" (238mm)	10-3/8" (259mm)							260	300	335	395	
5-1/2 Ft.	Fine	5/8" (16mm)	7-1/2" (188mm)	8-3/8" (209mm)				200	225	250	285	325	360		
	Medium	7/8" (22mm)	8-1/2" (213mm)	9-5/8" (241mm)						285	320	370	420	460	
	Coarse	1" (25mm)	9-5/8" (241mm)	10-3/4" (269mm)							330	390	460	500	700
(1676mm)	Extra Coarse	1-1/2" (38mm)	13-1/4" (331mm)	14-1/2" (368mm)									475	525	750
7 Ft. HD	Fine	3/4" (19mm)	10-1/8" (253mm)	11-1/8" (278mm)					420	450	550	680	800		
	Medium	1" (25mm)	12-1/8" (303mm)	13-3/8" (334mm)							670	800	890	1100	
	Coarse	1-1/4" (31mm)	13-3/8" (334mm)	14-3/4" (369mm)								870	930	1200	1400
(2134mm)	Extra Coarse	1-1/2" (38mm)	16-3/4" (425mm)	18-1/8" (460mm)									970	1300	1500
7 Ft. SHD	CONSULT FACTORY FOR CAPACITIES														

STANDARD SYMONS CONE CRUSHER CAPACITY CHART

STANDARD SYMONS CONE CRUSHERS - CAVITIES * FEED OPENINGS * PRODUCT SIZES * CAPACITIES

CLOSE CIRCUIT - CAPACITIES IN TONS (2000 LB) PER HOUR BASED ON CLOSE CIRCUIT OPERATION

Size	Type of Cavity	Recommended minimum discharge setting A	Feed opening with min. recommended discharge setting A		Effective square opening on circuit screen: 1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		7/8" (22mm)		1" (25mm)		1-1/4" (31mm)		1-1/2" (38mm)		2" (51mm)		2-1/2" (64mm)	
					Recommended closed side settings for closed circuit operation: 1/4" (6mm)		3/8" (10mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		3/4" (19mm)		7/8" (22mm)		1" (25mm)		1-1/4" (32mm)		1-1/2" (38mm)	
			B Closed side	B Open side	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2
2 Ft.	Fine	1/4" (6mm)	2-1/4" (56mm)	2-7/8" (72mm)	10	20	12	24	16	28	20	30	24	35	28	42	32	42	40	50	48	58				
	Coarse	3/8" (9mm)	3-1/4" (83mm)	3-3/4" (95mm)			12	24	16	28	20	30	24	35	28	42	32	42	40	50	48	58				
(610mm)	Extra Coarse	1/2" (13mm)	4" (100mm)	4-3/8" (109mm)							20	30	24	35	28	42	32	42	40	55	48	65				
3 Ft.	Fine	3/8" (9mm)	3-5/16" (83mm)	4-1/16" (102mm)			35	65	40	70	45	75	60	90	70	105	80	105	95	120	120	150	145	170		
	Coarse	1/2" (13mm)	6-3/8" (159mm)	7" (175mm)							45	75	60	90	75	110	85	110	100	125	120	150	145	170		
(914mm)	Extra Coarse	1" (25mm)	6-1/2" (163mm)	7-1/8" (178mm)											75	110										
4 Ft.	Fine	3/8" (9mm)	5" (127mm)	5-1/4" (131mm)			50	95	55	95	70	105	85	125	100	150	120	155	130	160	165	200				
	Medium	1/2" (13mm)	6-1/8" (156mm)	6-1/4" (156mm)							70	110	100	145	110	160	125	165	140	170	170	210	195	235		
	Coarse	3/4" (19mm)	7-1/8" (178mm)	7-5/8" (191mm)											115	175	130	175	150	185	170	210	195	235		
(1219mm)	Extra Coarse	1" (25mm)	9-1/4" (231mm)	10" (250mm)												175		175		185						
4-1/4 Ft.	Fine	1/2" (13mm)	4-3/8" (109mm)	5-3/8" (137mm)							95	135	105	155	125	185	145	190	175	220	205	205				
	Medium	5/8" (16mm)	7-1/2" (188mm)	8-1/4" (210mm)									120	175	135	200	155	205	190	235	215	260	235	280		
	Coarse	3/4" (19mm)	8-5/8" (216mm)	9-5/8" (241mm)											140	210	165	215	190	245	220	270	250	295		
(1295mm)	Extra Coarse	1" (25mm)	9-1/2" (238mm)	10-3/8" (259mm)																	225	275	260	310		
5-1/2 Ft.	Fine	5/8" (16mm)	7-1/2" (188mm)	8-3/8" (209mm)									160	235	180	265	210	270	240	300	300	360				
	Medium	7/8" (22mm)	8-1/2" (213mm)	9-5/8" (241mm)															250	310	310	375	330	390		
	Coarse	1" (25mm)	9-5/8" (241mm)	10-3/4" (269mm)																	315	380	340	400	400	465
(1676mm)	Extra Coarse	1-1/2" (38mm)	13-1/4" (331mm)	14-1/2" (368mm)																			350	410	420	490
7 Ft. HD	Fine	3/4" (19mm)	10-1/8" (253mm)	11-1/8" (278mm)																						
	Medium	1" (25mm)	12-1/8" (303mm)	13-3/8" (334mm)																						
	Coarse	1-1/4" (31mm)	12-3/8" (334mm)	14-3/4" (369mm)																						
(2134mm)	Extra Coarse	1-1/2" (38mm)	16-3/4" (425mm)	18-1/8" (460mm)																						
7 Ft. SHD	CONSULT FACTORY FOR CAPACITIES																									

SHORT HEAD SYMONS CONE CRUSHER CAPACITY CHART

SHORT HEAD SYMONS CONE CRUSHERS - CAVITIES * FEED OPENINGS * PRODUCT SIZES * CAPACITIES

OPEN CIRCUIT - CAPACITIES IN TONS (2000 LB) PER HOUR PASSING THROUGH THE CRUSHER AT INDICATED DISCHARGE SETTING "C"

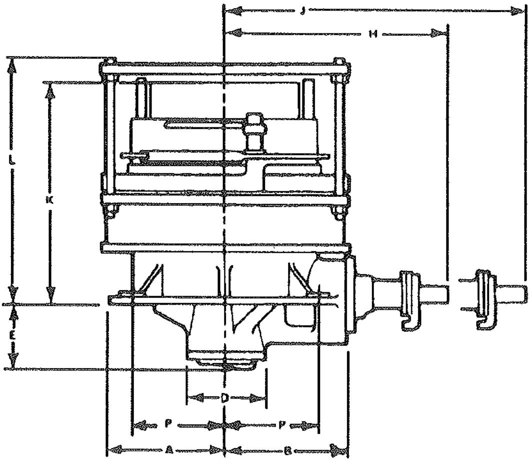
Size	Type of Cavity	Recommended minimum discharge setting C	Feed opening with min. recommended discharge setting C: D Closed side	D Open side	1/8" (3mm)	3/16" (5mm)	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	1" (25mm)
2 Ft.	Fine	1/8" (3mm)	3/4" (19mm)	1-3/8" (35mm)	10	18	20	30	40			
(610mm)	Coarse	3/16" (5mm)	1-1/2" (38mm)	2" (51mm)		18	24	32	45	55		
3 Ft.	Fine	1/8" (3mm)	1/2" (13mm)	1-5/8" (41mm)	30	45	60	75	100			
	Medium	1/8" (3mm)	1-5/16" (33mm)	2-3/8" (60mm)	30	45	60	75	100	110		
(914mm)	Coarse	1/4" (6mm)	2" (51mm)	3" (76mm)			65	80	105	125	140	
4 Ft.	Fine	3/16" (5mm)	1-1/8" (29mm)	2-1/4" (57mm)		55	85	95	135	145		
	Medium	5/16" (8mm)	1-3/4" (44mm)	2-7/8" (73mm)				100	145	160		
	Coarse	1/2" (13mm)	2-3/16" (56mm)	3-1/2" (89mm)					155	180	200	
(1219mm)	Extra Coarse	5/8" (16mm)	3-1/2" (89mm)	4-5/8" (117mm)					160	185	210	240
4-1/4 Ft.	Fine	1/8" (3mm)	1-1/8" (29mm)	2-1/2" (64mm)	40	65	90	115	150	180		
	Medium	1/4" (6mm)	2-1/8" (54mm)	3-1/2" (89mm)			90	115	150	180		
	Coarse	5/16" (8mm)	2-3/4" (70mm)	4-1/8" (105mm)				120	175	200	220	250
(1295)	Extra Coarse	5/8" (16mm)	3-7/8" (98mm)	5-1/4" (133mm)							230	260
5-1/2 Ft.	Fine	3/16" (5mm)	1-3/8" (35mm)	2-3/4" (70mm)		100	150	180	230			
	Medium	1/4" (6mm)	2-1/8" (54mm)	3-1/2" (89mm)			150	180	230	280	310	
	Coarse	3/8" (10mm)	3-7/8" (98mm)	5-1/4" (133mm)				210	280	310	340	370
(1676mm)	Extra Coarse	1/2" (13mm)	4-5/8" (117mm)	5-1/4" (133mm)					280	310	340	370
7 Ft. HD	Fine	3/16" (5mm)	2" (51mm)	4-1/8" (105mm)		210	300	360	400	450		
	Medium	3/8" (10mm)	3-3/4" (95mm)	5-1/4" (133mm)				390	450	500	560	
	Coarse	1/2" (13mm)	5" (127mm)	7" (178mm)					500	530	600	660
(2134mm)	Extra Coarse	5/8" (16mm)	6" (152mm)	8" (203mm)						560	650	720
7 Ft. SHD	CONSULT FACTORY FOR CAPACITIES											

SHORT HEAD SYMONS CONE CRUSHER CAPACITY CHART

SHORT HEAD SYMONS CONE CRUSHERS - CAVITIES * FEED OPENINGS * PRODUCT SIZES * CAPACITIES

CLOSE CIRCUIT - CAPACITIES IN TONS (2000 LB) PER HOUR BASED ON CLOSE CIRCUIT OPERATION

Size	Type of Cavity	Recommended minimum discharge setting C	Feed opening with min. recommended discharge setting C		Effective square opening on circuit screen: 1/8" (3mm)		3/16" (5mm)		1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		1" (25mm)	
					Recommended closed side settings for closed circuit operation: 1/8" (3mm)		3/16" (5mm)		3/16" (5mm)		1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)	
			D Closed side	D Open side	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2	Note 1	Note 2
2 Ft.	Fine	1/8" (3mm)	3/4" (19mm)	1-3/8" (35mm)	6	12	10	20	13	20	15	23	25	32	30	45				
	Coarse	3/16" (5mm)	1-1/2" (38mm)	2" (51mm)			10	20	13	20	18	27	26	35	35	50				
(610mm)																				
3 Ft.	Fine	1/8" (3mm)	1/2" (13mm)	1-5/8" (41mm)	15	30	20	40	30	45	50	65	70	85	80	110				
	Medium	1/8" (3mm)	1-5/16" (33mm)	2-3/8" (60mm)	15	30	20	40	30	45	50	65	70	85	80	110	95	135		
(914mm)	Coarse	1/4" (6mm)	2" (51mm)	3" (76mm)							55	70	75	90	85	115	105	145	130	150
4 Ft.	Fine	3/16" (5mm)	1-1/8" (29mm)	2-1/4" (57mm)			30	60	40	60	60	95	80	105	100	140				
	Medium	5/16" (8mm)	1-3/4" (44mm)	2-7/8" (73mm)									85	110	100	140	120	175		
	Coarse	1/2" (13mm)	2-3/16" (56mm)	3-1/2" (89mm)											115	160	145	210		
(1219mm)	Extra Coarse	5/8" (16mm)	3-1/2" (89mm)	4-5/8" (117mm)													150	220	170	205
4-1/4 Ft.	Fine	1/8" (3mm)	1-1/8" (29mm)	2-1/2" (64mm)	20	40	35	70	55	80	75	110	100	130	125	170				
	Medium	1/4" (6mm)	2-1/8" (54mm)	3-1/2" (89mm)							80	120	105	140	125	170				
	Coarse	5/16" (8mm)	2-3/4" (70mm)	4-1/8" (105mm)									110	150	140	200	175	250	200	260
(1295mm)	Extra Coarse	5/8" (16mm)	3-7/8" (98mm)	5-1/4" (133mm)													175	250	200	260
5-1/2 Ft.	Fine	3/16" (5mm)	1-3/8" (35mm)	2-3/4" (70mm)			65	130	90	140	135	200	175	220	210	270				
	Medium	1/4" (6mm)	2-1/8" (54mm)	3-1/2" (89mm)							135	200	175	220	210	270	245	350	280	340
	Coarse	3/8" (10mm)	3-7/8" (98mm)	5-1/4" (133mm)									180	240	220	280	250	360	320	385
(1676mm)	Extra Coarse	1/2" (13mm)	4-5/8" (117mm)	5-1/4" (133mm)											220	280	250	360	320	395
7 Ft. HD	Fine	3/16" (5mm)	2" (51mm)	4-1/8" (105mm)			120	240	160	230	240	360	315	390	360	450	420	500		
	Medium	3/8" (10mm)	3-3/4" (95mm)	5-1/4" (133mm)									315	420	360	500	420	550	500	600
	Coarse	1/2" (13mm)	5" (127mm)	7" (178mm)											380	540	450	650	550	660
(2134mm)	Extra Coarse	5/8" (16mm)	6" (152mm)	8" (203mm)													465	680	550	690
7 Ft. SHD	CONSULT FACTORY FOR CAPACITIES																			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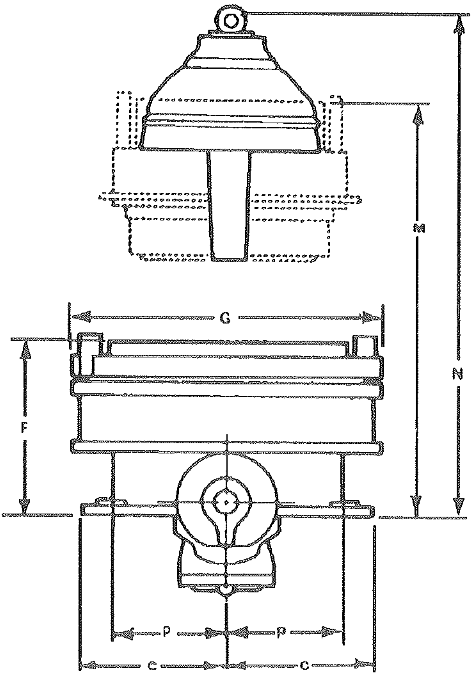
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CLEARANCE DIMENSIONS
STANDARD SYMONS CONE CRUSHER

Crusher Size	Feet (mm)	2′ (610)	3′ (914)	4′ (1219)	4-1/4′ (1295)	5-1/2′ (1676)	Heavy-duty 7′ (2134)	Super Heavy-duty 7′ (2134)
Crusher Centerline to Mainframe Flange	A & C (mm)	2′-3" (685)	2′-9" (838)	3′-1" (939)	3′-4" (1016)	4′-9" (1447)	5′-5" (1651)	5′-5" (1651)
Crusher Centerline to Countershaft Housing Face	B (mm)	2′-2" (660)	2′-11" (889)	3′-7" (1092)	3′-8" (1117)	4′-7" (1397)	5′-10" (1778)	5′-10" (1778)
Mainframe Cap Dia.	D (mm)	17" (431)	22" (558)	2′-0" (609)	2′-3" (685)	2′-8" (812)	3′-0" (914)	3′-0" (914)
Base to Bottom of Mainframe Cap	E (mm)	14" (355)	18" (457)	2′-1" (635)	2′-1" (635)	2′-8" (812)	3′-5" (1041)	3′-5" (1041)
Base to Top of Adjustment Ring	F (mm)	2′-10" (863)	3′-6" (1066)	3′-11" (1193)	4′-4" (1320)	5′-1" (1549)	5′-11" (1803)	6′-5" (1955)
Adjustment Ring Max. Dia.	G (mm)	4′-9" (1447)	6′-7" (2006)	7′-6" (2286)	7′-9" (2362)	10′-9" (3276)	12′-1" (3683)	14′-0" (4267)
Vertical Centerline to End of Countershaft	H (mm)	5′-1" (1549)	6′-1" (1854)	5′-5" (1651)	5′-6" (1676)	8′-1" (2463)	9′-9" (2971)	9′-9" (2971)
Clearance to Remove Countershaft Box Assembly	J (mm)	6′-7" (2006)	8′-3" (2514)	8′-1" (2463)	8′-2" (2489)	11′-6" (3505)	14′-2 (4318)	14′-2" (4318)
Max. Height Base to Top of Hopper or Lock Post*	K (mm)	3′-11" (1193)	5′-8" (1727)	6′-9" (2057)	6′-10" (2082)	8′-4" (2540)	9′-9" (2971)	10′-2" (3098)
	K′ (mm)			6′-9" (2057)	7′-5" (2260)	8′-10" (2692)	10′-3" (3124)	10′-10" (3302)
Max. Height Base to Top of Feed Posts	L (mm)	4′-4" (1320)	5′-11" (1803)	7′-3" (2209)	8′-5" (2565)	9′-10" (2997)	11′-3" (3429)	11′-11" (3632)
Clearance to Remove Bowl Assembly	M (mm)	5′-4" (1625)	7′-10" (2387)	10′-0" (3048)	10′-8" (3251)	12′-6" (3810)	14′-10" (4521)	15′-5" (4699)
Clearance To Remove Main Shaft Assembly	N (mm)	7′-0" (2133)	9′-2" (2794)	11′-2" (3403)	11′-7" (3530)	14′-0" (4267)	17′-5" (5308)	17′-11" (5461)
Foundation Bolt Location	P (mm)	1′-7-1/2" (495)	2′-2" (660)	2′-8-3/4" (832)	2′-10-3/4" (883)	3′-8-1/2" (1130)	4′-1" (1245)	4′-1" (1245)
Full Load Countershaft RPM		575	580	485	485	485	435	525
Horsepower (Electric)		30	100	150	200	300	400	500

CLEARANCE DIMENSIONS
SHORT HEAD SYMONS CONE CRUSHER

Crusher Size	Feet (mm)	2′ (610)	3′ (914)	4′ (1219)	4-1/4′ (1295)	5-1/2′ (1676)	Heavy-duty 7′ (2134)	Super Heavy-duty 7′ (2134)
Crusher Centerline to Mainframe Flange	A & C (mm)	2′-3" (685)	2′-9" (838)	3′-1" (939)	3′-4" (1016)	4′-9" (1447)	5′-5" (1651)	5′-5" (1651)
Crusher Centerline to Countershaft Housing Face	B (mm)	2′-2" (660)	2′-11" (889)	3′-7" (1092)	3′-8" (1117)	4′-7" (1397)	5′-10" (1778)	5′-10" (1778)
Mainframe Cap Dia.	D (mm)	17" (431)	22" (558)	2′-0" (609)	2′-3" (685)	2′-8" (812)	3′-0" (914)	3′-0" (914)
Base to Bottom of Mainframe Cap	E (mm)	14" (355)	18" (457)	2′-1" (635)	2′-1" (635)	2′-8" (812)	3′-5" (1041)	3′-5" (1041)
Base to Top of Adjustment Ring	F (mm)	2′-10" (863)	3′-6" (1066)	3′-11" (1193)	4′-4" (1320)	5′-1" (1549)	5′-11" (1803)	6′-5" (1955)
Adjustment Ring Max. Dia.	G (mm)	4′-9" (1447)	6′-7" (2006)	7′-6" (2286)	7′-9" (2362)	10′-9" (3276)	12′-1" (3683)	14′-0" (4267)
Vertical Centerline to End of Countershaft	H (mm)	5′-1" (1549)	6′-1" (1854)	5′-5" (1651)	5′-6" (1676)	8′-1" (2463)	9′-9" (2971)	9′-9" (2971)
Clearance to Remove Countershaft Box Assembly	J (mm)	6′-7" (2006)	8′-2" (2489)	8′-1" (2463)	8′-2" (2489)	11′-6" (3505)	14′-2 (4318)	14′-2" (4318)
Max. Height Base to Top of Hopper or Lock Post′	K (mm)	3′-11" (1193)	5′-10" (1778)	6′-4" (1930)	6′-10" (2082)	8′-4" (2540)	9′-9" (2971)	10′-2" (3098)
	K′ (mm)			7′-2" (2184)	7′-5" (2260)	8′-10" (2692)	10′-3" (3124)	10′-10" (3302)
Max. Height Base to Top of Feed Posts	L (mm)	4′-4" (1320)	5′-11" (1803)	7′-3" (2209)	8′-5" (2565)	9′-10" (2997)	11′-3" (3429)	11′-11" (3632)
Clearance to Remove Bowl Assembly	M (mm)	5′-6" (1676)	7′-9" (2362)	10′-1" (3073)	10′-2" (3098)	11′-7" (3530)	13′-9" (4191)	14′-1" (4292)
Clearance To Remove Main Shaft Assembly	N (mm)	7′-0" (2133)	8′-5" (2565)	11′-2" (3403)	11′-9" (3581)	12′-8" (3860)	15′-2" (4622)	16′-10" (5130)
Foundation Bolt Location	P (mm)	1′-7-1/2" (495)	2′-2" (660)	2′-8-3/4" (832)	2′-10-3/4" (883)	3′-8-1/2" (1130)	4′-1" (1245)	4′-1" (1245)
Full Load Countershaft RPM		575	580	500	485	485	435	525
Horsepower (Electric)		30	100	150	200	300	400	500

CRUSHER WEIGHTS
STANDARD SYMONS CONE

Weight of Complete Crusher and Weights of Assemblies

Crusher Size	Feet (mm)	2' (610)	3' (914)	4' (1219)	4-1/4' (1295)	5-1/2' (1676)	Heavy-duty 7' (2134)	Super Heavy-duty 7' (2134)
Crusher Complete	Lbs. (Kgs.)	9,900 (4484)	22,000 (9966)	37,100 (16806)	49,500 (22423)	95,400 (43216)	148,500 (67270)	191,200 (86613)
Mainframe, Adjustment Ring, Springs, Step Bearing Plants, Eccentric, Countershaft, Countershaft Box, Crusher Sheave and Socket	Lbs. (Kgs.)	6.500 (2944)	14,300 (6477)	23,000 (10419)	30,700 (13907)	56,100 (25413)	85,000 (38505)	127,200 (57621)
Mainframe, Adjustment Ring, and Springs	Lbs. (Kgs.)	4,300 (1947)	10,500 (4756)	16,800 (7610)	24,200 (10962)	43,400 (19660)	63,800 (28901)	106,000 (48018)
Mainframe, Including Mainframe Cap, Outer Eccentric Bushing, and Mainframe Liner	Lbs. (Kgs.)	2,800 (1268)	5,800 (2627)	10,300 (4665)	12,100 (5481)	25,500 (11551)	40,000 (18120)	55,300 (25050)
Bowl, Bowl Liner and Adjustment Cap Assembly	Lbs. (Kgs.)	2,100 (951)	4,000 (1812)	8,400 (3805)	10,800 (4892)	22,600 (10237)	32,700 (14813)	33,200 (15039)
Head, Main Shaft, Mantle, and Feed Plate Assembly	Lbs. (Kgs.)	1,300 (588)	3,700 (1676)	5,700 (2582)	8,000 (3624)	16,700 (7565)	30,800 (13952)	30,800 (13952)
Countershaft Box, Countershaft Assembly	Lbs. (Kgs.)	1,100 (498)	2,000 (906)	2,700 (1223)	2,800 (1268)	4,700 (2129)	7,000 (3171)	7,000 (3171)
Eccentric Assembly	Lbs. (Kgs.)	600 (271)	1,200 (543)	2,200 (996)	2,300 (1041)	4,200 (1902)	7,600 (3442)	7,600 (3442)

CRUSHER WEIGHTS
SHORT HEAD SYMONS CONE

Weight of Complete Crusher and Weights of Assemblies

Crusher Size	Feet (mm)	2' (610)	3' (914)	4' (1219)	4-1/4' (1295)	5-1/2' (1676)	Heavy-duty 7' (2134)	Super Heavy-duty 7' (2134)
Crusher Complete	Lbs. (Kgs.)	10,100 (4575)	23,200 (10509)	38,800 (17576)	49,800 (22559)	96,700 (43805)	154,600 (70033)	197,300 (89376)
Mainframe, Adjustment Ring, Springs, Step Bearing Plants, Eccentric, Countershaft, Countershaft Box, Crusher Sheave and Socket	Lbs. (Kgs.)	6.500 (2944)	14,300 (6477)	23,000 (10419)	30,700 (13907)	56,100 (25413)	85,000 (38505)	127,200 (57621)
Mainframe, Adjustment Ring, and Springs	Lbs. (Kgs.)	4,300 (1947)	10,500 (4756)	16,800 (7610)	24,200 (10962)	43,400 (19660)	63,800 (28901)	106,000 (48018)
Mainframe, Including Mainframe Cap, Outer Eccentric Bushing, and Mainframe Liner	Lbs. (Kgs.)	2,800 (1268)	5,800 (2627)	10,300 (4665)	12,100 (5481)	25,500 (11551)	40,000 (18120)	55,300 (25050)
Bowl, Bowl Liner and Adjustment Cap Assembly	Lbs. (Kgs.)	1,900 (860)	4,500 (2038)	8,800 (3986)	9,600 (4348)	20,200 (9150)	31,600 (14314)	32,100 (14541)
Head, Main Shaft, Mantle, and Feed Plate Assembly	Lbs. (Kgs.)	1,700 (770)	4,400 (1993)	7,000 (3171)	9,500 (4303)	20,400 (9241)	38,000 (17214)	38,000 (17214)
Countershaft Box, Countershaft Assembly	Lbs. (Kgs.)	1,100 (498)	2,000 (906)	2,700 (1223)	2,800 (1268)	4,700 (2129)	7,000 (3171)	7,000 (3171)
Eccentric Assembly	Lbs. (Kgs.)	600 (271)	1,200 (543)	2,200 (996)	2,300 (1041)	4,200 (1902)	7,600 (3442)	7,600 (3442)

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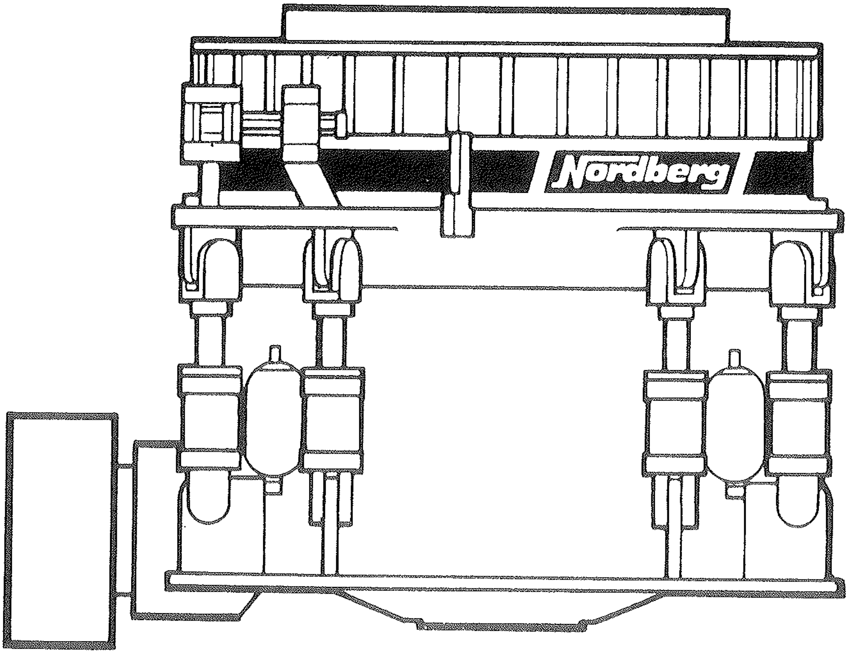
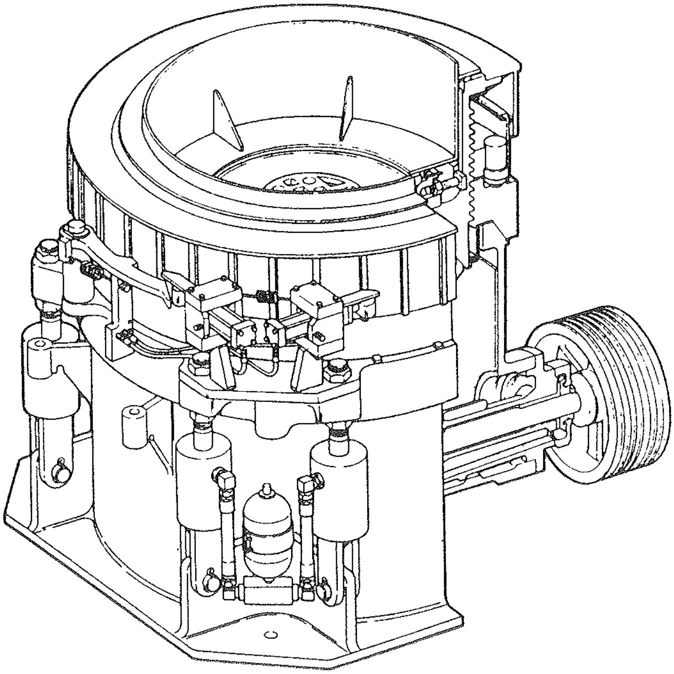
Omnicone Crushers



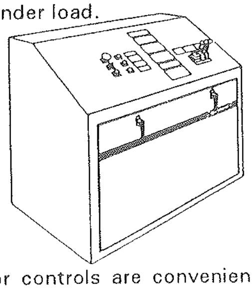
7-1 OMNICONE CRUSHERS

EASY TO OPERATE, ADJUST AND MAINTAIN



Hydraulic Control Setting

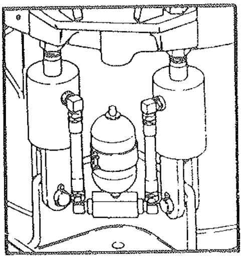
Omnicone Crushers are equipped with a fingertip hydraulic control that adjusts the crusher setting, for optimum performance, while the crusher is operating under load.



All operator controls are conveniently mounted on a remote control console to eliminate the need for an operator to approach the crusher during operation.

Hydraulic Release & Cleaning

Each Omnicone features a hydraulic system that provides a safe and fast way to clear a jammed cavity. Should the crusher become plugged, the operator merely pushes levers on the remote control console to clear the crusher.



TYPICAL OMNICONE PRODUCT GRADATION

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Closed Side Setting of Crusher, Inch									
	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/4"	1-1/2"	2"
4"										100
3"								100	100	93
2"						100	100	94	89	72
1-1/2"				100	100	96	93	87	72	53
1"			100	96	89	88	72	60	50	35
3/4"		100	93	87	72	60	53	43	32	25
1/2"	100	89	72	60	50	43	35	28	23	18
3/8"	93	72	53	43	32	28	25	20	16	12
1/4"	72	50	35	28	23	20	18	14	11	9
3/16"	53	32	25	20	16	14	12	10	9	8
No. 6	35	23	18	14	11	10	9	8	7	
No. 8	25	16	12	10	9	8	8	7		

*Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

TYPICAL OMNICONE PRODUCT GRADATIONS

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Millimeter	Closed Side Setting of Crusher, Millimeter									
	6mm	10mm	13mm	16mm	19mm	22mm	25mm	32mm	38mm	51mm
102mm										100
76mm								100	100	93
51mm						100	100	94	89	72
38mm				100	100	96	93	87	72	53
25mm			100	96	89	88	72	60	50	35
19mm		100	93	87	72	60	53	43	32	25
13mm	100	89	72	60	50	43	35	28	23	18
10mm	93	72	53	43	32	28	25	20	16	12
6mm	72	50	35	28	23	20	18	14	11	9
5mm	53	32	25	20	16	14	12	10	9	8
3mm	35	23	18	14	11	10	9	8	7	
2mm	25	16	12	10	9	8	8	7		

Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

CONE CRUSHER CAPACITY CHARTS

Cone crusher capacity charts are developed for use as an application tool to properly utilize the Omnicone's capabilities. The crusher is one component of the circuit. As such, its performance is in part dependent on the proper selection and operation of feeders, conveyors, screens, supporting structure, electric motors, drive components and surge bins. Where used, attention to the following factors will enhance crusher capacity and performance.

1. Proper selection of crushing chamber for material to be crushed.
2. A feed grading containing proper distribution of the particle sizes.
3. Controlled feed rate.
4. Proper feed distribution 360 degrees around the crushing chamber.
5. Discharge conveyor sized to carry maximum crusher capacity.
6. Properly sized scalping and closed circuit screens.
7. Automation controls.
8. Adequate crusher discharge area.

The following factors will detract from crusher capacity and performance.

1. Sticky material in crusher feed.
2. Fines in crusher feed (smaller than crusher setting) exceeding 10% of crusher capacity.
3. Excessive feed moisture.
4. Feed segregation in crusher cavity.
5. Improper feed distribution around circumference of crushing cavity.
6. Lack of feed control.
7. Insufficient use of recommended connected horsepower.
8. Insufficient conveyor capacity.
9. Insufficient scalper and closed circuit screen capacities.
10. Insufficient crusher discharge area.
11. Extremely hard or tough material.
12. Operation of crusher at less than recommended full load countershaft speed.

Capacities shown are neither maximum nor minimum, and are based on results secured in actual practice. The figures shown apply to short tons of material weighing 100 pounds per cubic foot, and are based on a properly graded feed.

Note: To convert short tons to metric tons, multiply short tons by .907.

The capacities and gradations shown in the tables are based on results obtained from thousands of installations worldwide, crushing the broadest range of ores, rocks and minerals to determine effect of individual conditions, consult Nordberg.

OMNICONE CAVITY SELECTION

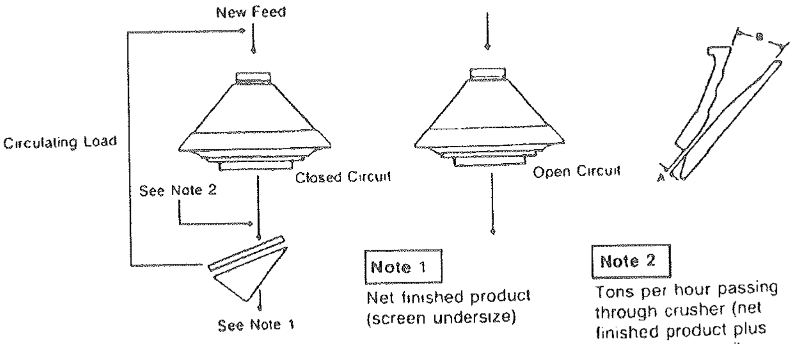
Crushing Cavity Selection

Preliminary selection of crushing cavity is based on feed analysis, abrasiveness of the rock, and crusher product required. The feed should be generally no larger than 80% of "B" dimension at open side.

		STANDARD		SHORT HEAD	
Crusher Size	Type of Cavity	Minimum Setting "A"**	Feed Opening "B" Open Side*	Minimum Setting "A"**	Feed Opening "B" Open Side*
1144	Fine	5/8" (16mm)	4-1/2" (114mm)	1/4" (6mm)	2-1/2" (64mm)
	Medium	3/4" (19mm)	5-3/4" (146mm)	1/4" (6mm)	3-1/8" (80mm)
	Coarse	7/8" (22mm)	7-3/8" (186mm)	3/8" (9mm)	3-1/2" (89mm)
1352	Fine	5/8" (16mm)	5" (129mm)	1/4" (6mm)	2-1/2" (64mm)
	Medium	7/8" (22mm)	7-3/8" (188mm)	1/4" (6mm)	3-1/2" (89mm)
	Coarse	1" (25mm)	9-1/4" (233mm)	3/8" (9mm)	4-3/8" (113mm)
1560	Fine	7/8" (22mm)	7-1/4" (184mm)	1/4" (6mm)	2-5/8" (68mm)
	Medium	1" (25mm)	9-3/8" (238mm)	5/16" (8mm)	4" (102mm)
	Coarse	1-1/8" (28mm)	11-1/8" (283mm)	3/8" (9mm)	5-1/4" (135mm)

* Open Side feed opening "B" is at minimum setting "A".

** The minimum setting is slightly larger than the setting which will cause ring bounce. Depending on the crushing characteristics of the rock, this setting can change.



Note 1
Net finished product (screen undersize)

Note 2
Tons per hour passing through crusher (net finished product plus recirculating load)

OMNICONE CRUSHER CAPACITY CHARTS

Open Circuit Capacities in tons (2,000 lbs.) per hour

Closed Side Discharge Setting "A"

Size	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	7/8" (22mm)	1" (25mm)	1-1/4" (32mm)	1-1/2" (38mm)	2" (51mm)
1144	70-80	90-110	135-155	145-180	175-200	185-215	200-230	230-260	250-280	
1352	80-90	115-125	150-170	180-200	200-225	215-245	250-275	260-310	280-345	330-385
1560	135-150	170-200	230-265	260-300	300-340	320-360	340-390	380-440	420-490	520-600

Closed Circuit Capacities in tons (2,000 lbs.) per hour

Size	Product Size (inches and millimeters)															
	1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		1" (25mm)		1-1/4" (32mm)		1-1/2" (38mm)	
	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2
1144	55-60	80-90	70-80	100-120	100-115	140-170	115-140	160-210	130-160	180-220	150-180	200-230	165-180	230-260	180-190	250-280
1352	60-70	90-100	90-100	125-150	120-135	170-200	135-160	195-230	155-180	220-260	170-200	260-300	190-215	290-315	205-230	280-350
1560	90-100	145-165	135-150	195-230	175-190	250-280	210-230	300-340	230-260	300-370	250-290	340-390	270-315	380-440	300-335	420-480

NOTE 1: Net finished product (screen undersize)

NOTE 2. Tons per hour passing through crusher (net finished product plus recirculating load)

OMNICONE CRUSHER CAPACITY CHARTS

Open Circuit Capacities in metric tons (2,200 lbs.) per hour

Closed Side Discharge Setting "A"

Size	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	7/8" (22mm)	1" (25mm)	1-1/4" (32mm)	1-1/2" (38mm)	2" (51mm)
1144	64-73	82-100	122-141	132-163	159-181	168-195	181-209	209-236	227-254	
1352	73-82	104-113	136-154	163-181	181-204	195-222	227-249	236-281	254-313	299-349
1560	122-136	154-181	209-240	236-272	272-308	290-327	308-354	345-399	381-445	472-544

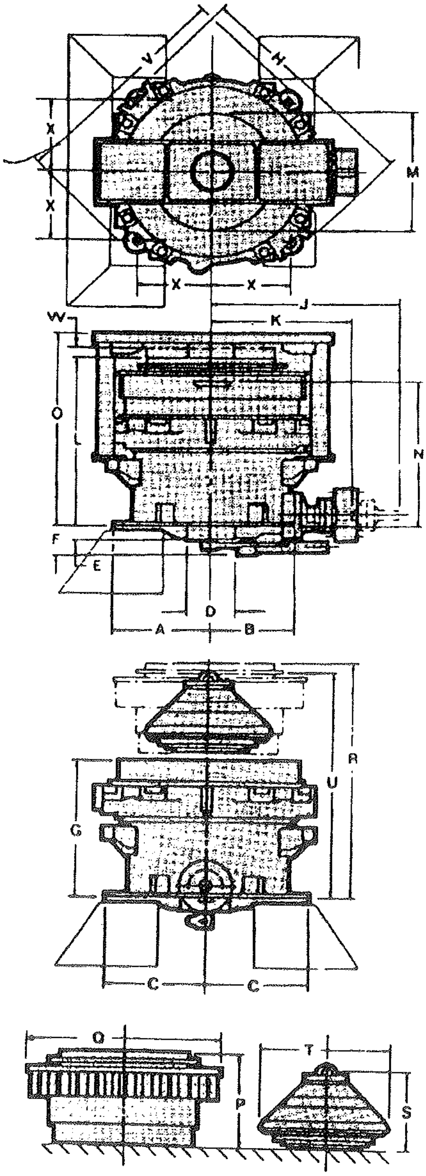
Closed Circuit Capacities in metric tons (2,200 lbs.) per hour

Size	Product Size (inches and millimeters)															
	1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		1" (25mm)		1-1/4" (32mm)		1-1/2" (38mm)	
	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2
1144	50-54	73-82	64-73	91-109	91-104	127-154	104-127	145-191	118-145	163-200	136-163	181-209	150-163	209-236	163-172	227-254
1352	54-64	82-91	82-91	113-136	109-122	154-181	122-145	177-209	141-163	200-236	154-181	236-272	172-195	263-286	186-209	254-318
1560	82-91	132-150	122-136	177-209	159-172	227-254	191-209	272-308	209-236	272-336	227-263	308-354	245-286	345-399	272-304	381-435

NOTE 1: Net finished product (screen undersize)

NOTE 2: Tons per hour passing through crusher (net finished product plus recirculating load)

OMNICONE CLEARANCE DIMENSIONS



OMNICONE CLEARANCE DIMENSIONS

MODEL NO.	1144		1352		1560	
	MM	IN	MM	IN	MM	IN
A Main Frame Flange	910	35-7/8	1060	41-3/4	1225	48-1/4
B Main Frame Flange	910	35-7/8	1060	41-3/4	1215	47-7/8
C Main Frame Flange	910	35-7/8	1060	41-3/4	1225	48-1/4
D Main Frame Hub Diameter	450	17-3/4	500	19-3/4	580	22-7/8
E To Bottom of Main Frame Hub	60	2-3/8	160	6-3/8	140	5-1/2
F To Bottom of Oil Piping	195	7-3/4	315	12-1/2	300	11-7/8
G To Top of Dust Shell (Hydraulic)	1445	56-7/8	1575	62	1795	70-3/4
H Adjustment Ring Maximum Diameter	2340	92-1/8	2580	101-5/8	2900	114-1/4
J Clearance Required for Removing Countershaft Assembly	2000	78-3/4	2640	104	3165	124-5/8
K To End of Countershaft	1290	50-7/8	1525	60-1/8	1640	64-5/8
L Maximum Height to Top of Feed Hopper	1790	70-1/2	1960	77-1/4	2200	86-5/8
M Inside Diameter of Feed Hopper	1146	45-1/8	1384	54-1/2	1586	62-1/2
N To Top of Feed Plate	1290	50-7/8	1420	56	1710	67-3/8
O To Top of Feed Platform	1940	76-3/8	2140	84-1/4	2425	95-1/2
P Overall Height of Bowl Assembly	990	39	1035	40-3/4	1060	41-3/4
Q Adjustment Cap Maximum Diameter - (Hydraulic)	1990	78-3/8	2180	85-7/8	2376	93-1/2
R Clearance Required for Removing Bowl Assembly	2485	97-7/8	2660	104-3/4	2905	114-3/8
S Overall Height of Head Assembly	830	32-3/4	915	36-1/8	1225	48-1/4
T Head or Mantle Maximum Diameter	1150	45-1/4	1345	53	1560	61-1/2
U Clearance Required for Removing Head Assembly	2330	91-3/4	2540	100	3070	120-7/8
V Tramp Release Across Corners	2150	84-5/8	2570	101-1/4	2900	114-1/4
W Additional Upward Travel of Feed Hopper During Clearing Stroke	76	3	83	3-1/4	120	4-3/4
X Mounting Hole Location	660	26	832	32-3/4	883	34-3/4
Y Main Frame Discharge Opening Diameter	1490	59	1726	68	2040	80

NOTE: 'Y' not shown in dimension drawing.

OMNICONE WEIGHTS

Complete Crusher and Assembly Weights

Model 1144		Model 1352		Model 1560	
Kg.	Lbs.	Kg.	Lbs.	Kg.	Lbs.
Crusher Complete					
14,330	31,530	19,500	42,950	29,350	64,570
Main Frame, Adjustment Ring, Tramp Release, Eccentric, Socket, Countershaft and Crusher Sheave					
8,295	18,250	12,000	26,430	16,900	37,180
Main Frame, Adjustment Ring and Tramp Release					
8,045	15,500	9,650	21,250	13,780	30,320
Main Frame, Including Main Shaft and Main Frame Liner					
3,070	6,750	5,300	11,670	8,050	17,710
Bowl, Bowl Liner and Hopper					
6,635	8,000	4,830	10,640	7,820	17,200
Head, Mantle and Feed Plate					
2,180	4,800	2,710	5,970	4,330	9,530
Countershaft, Countershaft Box and Crusher Sheave					
400	880	900	1,980	900	1,980
Eccentric					
700	1,540	1,280	2,820	1,970	4,330
Socket					
150	330	180	400	250	550
Feed Platform					
220	480	270	590	300	660
Since various assembly combinations are available in each crusher size, and because of manufacturing variations, the weights shown above are approximate. All weights can vary ± 5%.					
Recommended Power					
110 KW	150 HP	150 KW	200 HP	200 KW	250 HP
Countershaft Speed (Full Load)					
765-842 RPM		715-787 RPM		650-715 RPM	

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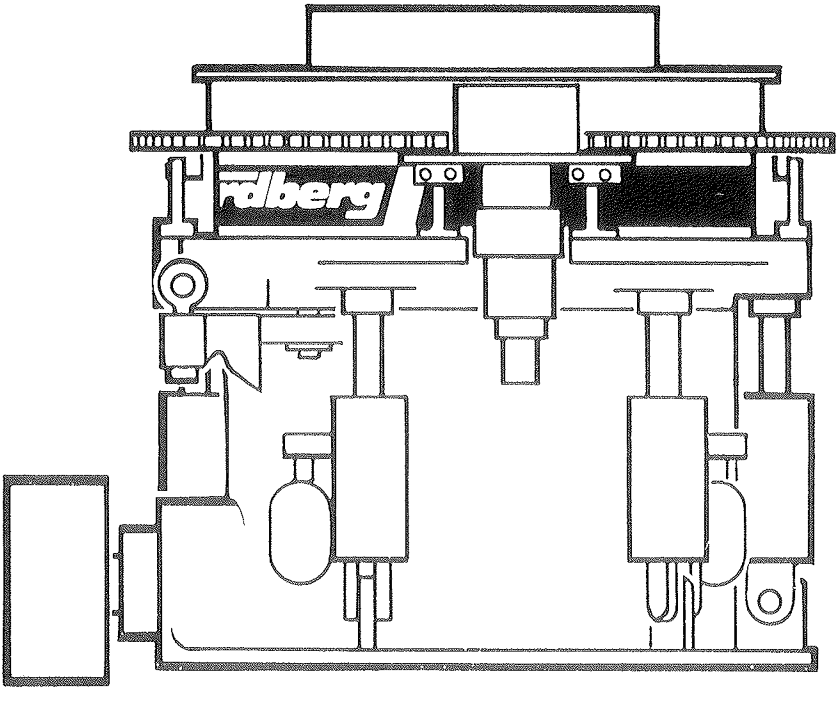
HP Series Cone Crushers



HP GRADATIONS

Product Size Inches	Closed Side Setting of Crusher, Inch						
	1/4"	3/8"	1/2"	3/4"	1"	1-1/2"	2"
4"							100
3"						100	98
2"					100	98	82
1-1/2"				100	98	82	65
1"			100	98	82	59	46
3/4"		100	98	82	65	46	36
1/2"	100	98	82	59	46	32	25
3/8"	98	82	65	46	36	25	20
1/4"	82	59	46	32	25	18	15
No. 4	64	45	35	25	20	14	11
No. 6	48	33	26	19	15	11	9
No. 8	35	25	20	14	12	8	7
No. 10	26	19	15	11	9	6	5

*Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.**

HP GRADATIONS

Product Size Millimeters	Closed Side Setting of Crusher, Millimeters						
	6mm	10mm	13mm	16mm	25mm	38mm	51mm
102mm							100
76mm						100	98
51mm					100	98	82
38mm				100	98	82	65
25mm			100	98	82	59	46
19mm		100	98	82	65	46	36
13mm	100	98	82	59	46	32	25
10mm	98	82	65	46	36	25	20
6mm	82	59	46	32	25	18	15
5mm	64	45	35	25	20	14	11
3mm	48	33	26	19	15	11	9
2mm	35	25	20	14	12	8	7
1.9mm	26	19	15	11	9	6	5

*Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

CONE CRUSHER CAPACITY CHARTS

Cone crusher capacity charts are developed for use as an application tool to properly utilize the HP crusher's capabilities. The crusher is one component of the circuit. As such, its performance is in part dependent on the proper selection and operation of feeders, conveyors, screens, supporting structure, electric motors, drive components and surge bins. Where used, attention to the following factors will enhance crusher capacity and performance.

1. Proper selection of crushing chamber for material to be crushed.
2. A feed grading containing proper distribution of the particle sizes.
3. Controlled feed rate.
4. Proper feed distribution 360 degrees around the crushing chamber.
5. Discharge conveyor sized to carry maximum crusher capacity.
6. Properly sized scalping and closed circuit screens.
7. Automation controls.
8. Adequate crusher discharge area.

The following factors will detract from crusher capacity and performance.

1. Sticky material in crusher feed.
2. Fines in crusher feed (smaller than crusher setting) exceeding 10% of crusher capacity.
3. Excessive feed moisture.
4. Feed segregation in crusher cavity.
5. Improper feed distribution around circumference of crushing cavity.
6. Lack of feed control.
7. Insufficient use of recommended connected horsepower.
8. Insufficient conveyor capacity.
9. Insufficient scalper and closed circuit screen capacities.
10. Insufficient crusher discharge area.
11. Extremely hard or tough material.
12. Operation of crusher at less than recommended full load countershaft speed.

Capacities shown are neither maximum nor minimum, and are based on results secured in actual practice. The figures shown apply to short tons of material weighing 100 pounds per cubic foot, and are based on a properly graded feed.

Note: To convert short tons to metric tons, multiply short tons by .907.

The capacities and gradations shown in the tables are based on results obtained from thousands of installations worldwide, crushing the broadest range of ores, rocks and minerals to determine effect of individual conditions, consult Nordberg.

HP CAVITY SELECTION

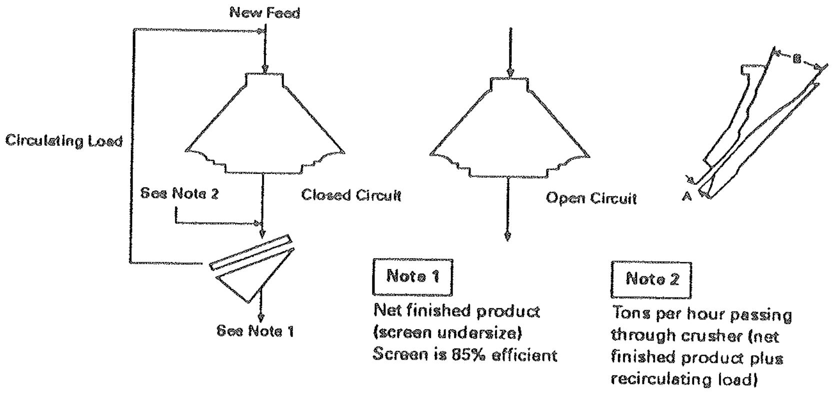
Crushing Cavity Selection

Preliminary selection of crushing cavity is based on feed analysis, abrasiveness of the rock, and crusher product required. The feed should be generally no larger than "B" dimension at closed side.

		STANDARD				SHORT HEAD			
Crusher Size	Type of Cavity	Minimum Setting "A"[1]		Feed Opening "B"[2]		Minimum Setting "A"[1]		Feed Opening "B"[2]	
HP200	Fine	.50"	(13mm)	3.75"	(95mm)	.20"	(5mm)	.79"	(20mm)
	Medium	.62"	(16mm)	4.92"	(125mm)	.24"	(6mm)	2.05"	(52mm)
	Coarse	.75"	(19mm)	7.24"	(184mm)	.39"	(10mm)	2.99"	(76mm)
HP300	Fine	.54"	(14mm)	4.09"	(104mm)	.20"	(5mm)	.94"	(24mm)
	Medium	.62"	(16mm)	5.87"	(149mm)	.24"	(6mm)	2.13"	(54mm)
	Coarse	.75"	(19mm)	8.15"	(207mm)	.38"	(10mm)	3.15"	(80mm)
HP500	Fine	.63"	(16mm)	5.12"	(130mm)	.24"	(6mm)	.75"	(19mm)
	Medium	.87"	(22mm)	6.69"	(170mm)	.38"	(10mm)	2.28"	(58mm)
	Coarse	1.18"	(30mm)	11.69	(297mm)	.38"	(10mm)	3.54"	(90mm)
HP700	Fine	.75"	(19mm)	8.27"	(210mm)	.20"	(5mm)	1.50"	(38mm)
	Medium	1.00"	(25mm)	10.39"	(264mm)	.38"	(10mm)	3.58"	(91mm)
	Coarse	1.25"	(32mm)	14.33"	(364mm)	.50"	(13mm)	6.02"	(153mm)

[1] The minimum setting is the setting which will cause ring bounce. Depending on the crushing characteristics of the rock, this setting can change.

[2] Feed opening "B" is at minimum setting "A".



NOTES

HP CRUSHER CAPACITY CHARTS

Open Circuit Capacities in tons (2,000 lbs.) per hour										
Closed Side Discharge Setting "A"										
Size	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	7/8" (22mm)	1" (25mm)	1-1/4" (32mm)	1-1/2" (38mm)	2" (51mm)
HP200	80-90	100-120	140-160	155-185	180-200	190-215	205-235	225-255	245-275	---
HP300	95-105	125-140	170-195	210-235	240-260	260-280	280-300	285-325	305-345	340-375
HP500	165-195	215-245	275-305	325-355	375-405	400-430	430-460	475-515	525-560	590-620
HP700	290-310	350-390	400-450	500-530	585-620	630-660	650-700	750-780	830-860	950-1000

Closed Circuit Capacities in tons (2,000 lbs.) per hour																
Size	Product Size (inches and millimeters)															
	1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		1" (25mm)		1-1/4" (32mm)		1-1/2" (38mm)	
	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2
HP200	60-70	85-100	75-90	105-130	110-120	155-180	120-140	175-205	135-150	190-210	150-170	215-245	155-185	225-265	170-195	245-285
HP300	70-80	100-115	95-105	135-165	130-150	185-215	160-180	230-260	175-195	250-275	200-220	285-315	205-235	295-355	215-245	310-350
HP500	125-150	180-215	165-185	235-265	210-235	300-335	245-270	355-390	270-295	390-425	315-355	450-480	335-360	480-520	370-390	530-565
HP700	210-225	300-320	260-290	370-410	295-335	420-475	365-395	525-560	410-440	590-630	460-500	655-710	525-550	755-785	580-600	835-865

NOTE 1: Net finished product (screen undersize) Screen is 85% efficient

NOTE 2: Tons per hour passing through crusher (net finished product plus recirculating load)

HP CRUSHER CAPACITY CHARTS

Open Circuit Capacities in metric tons (2,200 lbs.) per hour

Closed Side Discharge Setting "A"

Size	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	7/8" (22mm)	1" (25mm)	1-1/4" (32mm)	1-1/2" (38mm)	2" (51mm)
HP200	73-82	91-109	127-145	141-168	163-181	172-195	186-213	204-231	222-249	---
HP300	86-95	113-127	154-177	191-213	218-236	236-254	254-272	259-295	277-313	308-340
HP500	150-177	195-222	249-277	295-322	340-367	363-390	390-417	431-467	476-508	535-562
HP700	263-281	227-354	363-408	454-481	531-562	571-599	590-635	680-707	753-780	862-907

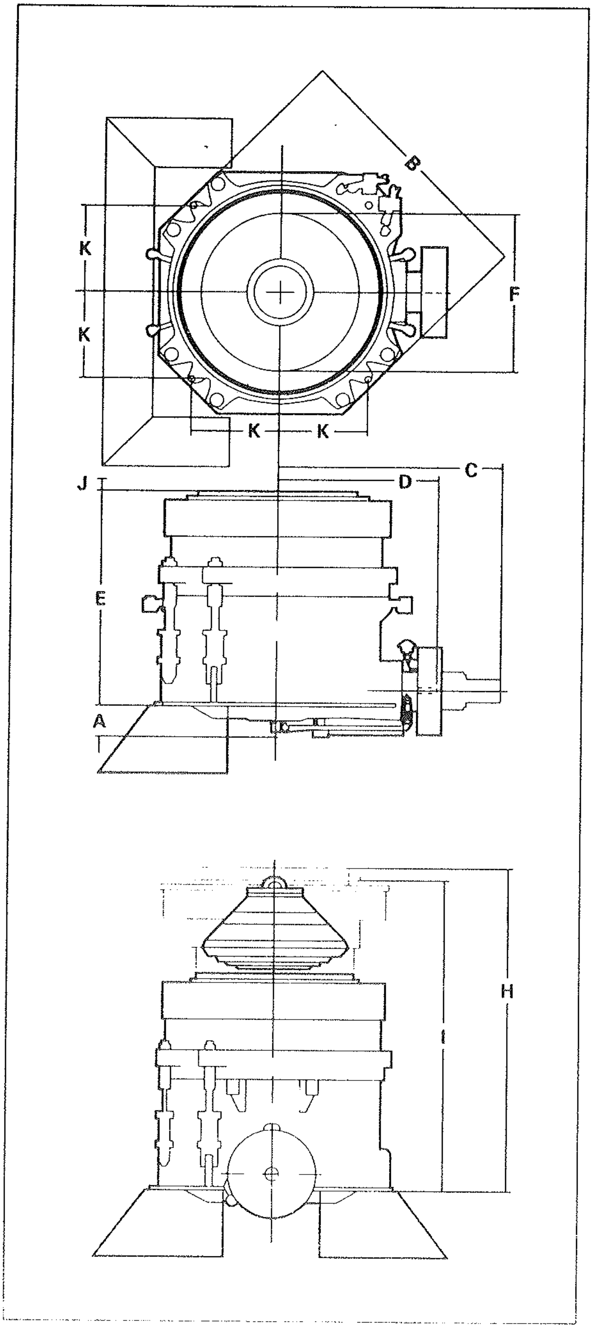
Closed Circuit Capacities in metric tons (2,200 lbs.) per hour

Size	Product Size (inches and millimeters)															
	1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		1" (25mm)		1-1/4" (32mm)		1-1/2" (38mm)	
	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2
HP200	54-64	77-91	68-82	95-118	100-109	141-163	109-127	154-186	122-136	172-190	136-154	195-222	141-168	204-240	154-177	222-258
HP300	64-73	91-104	86-95	122-141	118-136	168-195	145-163	209-236	159-177	227-249	181-200	258-286	186-213	268-322	195-222	281-317
HP500	113-136	163-195	150-168	213-240	190-213	272-304	222-245	322-354	245-268	354-385	286-322	408-435	304-327	435-472	336-354	481-512
HP700	190-204	272-290	236-263	336-372	268-304	381-431	331-358	476-508	372-399	535-571	417-454	594-644	476-499	685-712	526-544	757-785

NOTE 1: Net finished product (screen undersize) Screen is 85% efficient

NOTE 2: Tons per hour passing through crusher (net finished product plus recirculating load)

HP CLEARANCE DIMENSIONS



HP CLEARANCE DIMENSIONS

MODEL NO.	HP200		HP300		HP500		HP700	
	MM	IN	MM	IN	MM	IN	MM	IN
A To Bottom of Oil Piping	290	11-3/8	270	10-5/8	425	16-3/4	708	27-7/8
B Adjustment Ring Maximum Diameter	1760	69-1/4	2020	79-1/2	2730	107-1/2	3390	133-1/2
C Clearance Required for Removing Countershaft Assembly	1865	73-3/8	2020	79-1/2	2650	104-3/8	3450	136-7/8
D To End of Countershaft	1160	45-5/8	1350	53-1/8	1760	69-1/4	2225	87-7/8
E Maximum Height of Top	1605	63-1/4	1890	74-3/8	2290	90-1/8	2769	109
F Inside Diameter of Feed Hopper	940	37	1104	43-1/2	1535	60-1/2	1816	71-1/2
H Clearance Required for Removing Bowl Assembly	2155	84-7/8	2460	96-7/8	3300	129-7/8	3860	152
I Clearance Required for Removing Head Assembly	2115	83-1/4	2430	95-5/8	3165	124-5/8	3730	146-7/8
J Additional Upward Travel of Feed Hopper During Clearing Stroke	76	3	98	3-7/8	175	6-7/8	195	7-5/8
K Mounting Hole Location *5-1/2 FT.-**7 FT.	545	21-1/2	660	26	883	34-3/4	1130 1245	44-1/2* 49**
L Main Frame Discharge Opening Diameter	1220	48	1490	59	2045	80-1/2	2400	94-1/2

NOTE: 'L' not shown in dimension drawing.

HP WEIGHTS

	HP200		HP300		HP500		HP700	
	Kg.	Lbs.	Kg.	Lbs.	Kg.	Lbs.	Kg.	Lbs.
Crusher Complete	10,350	22,800	14,900	32,800	30,000	66,000	61,900	136,500
Bowl, Bowl Liner, Adj. Cap, Hopper	2,585	5,695	3,230	7,115	7,200	15,800	16,350	36,050
Head, Mantle and Feed Plate	1,050	2,315	1,825	4,020	4,900	10,700	8,720	4,015
Recommended Power	110KW	150HP	200KW	250HP	300KW	400HP	450KW	600HP
Countershaft Speed	RPM							
	1120-1230		1020-1120		865-951		832-913	

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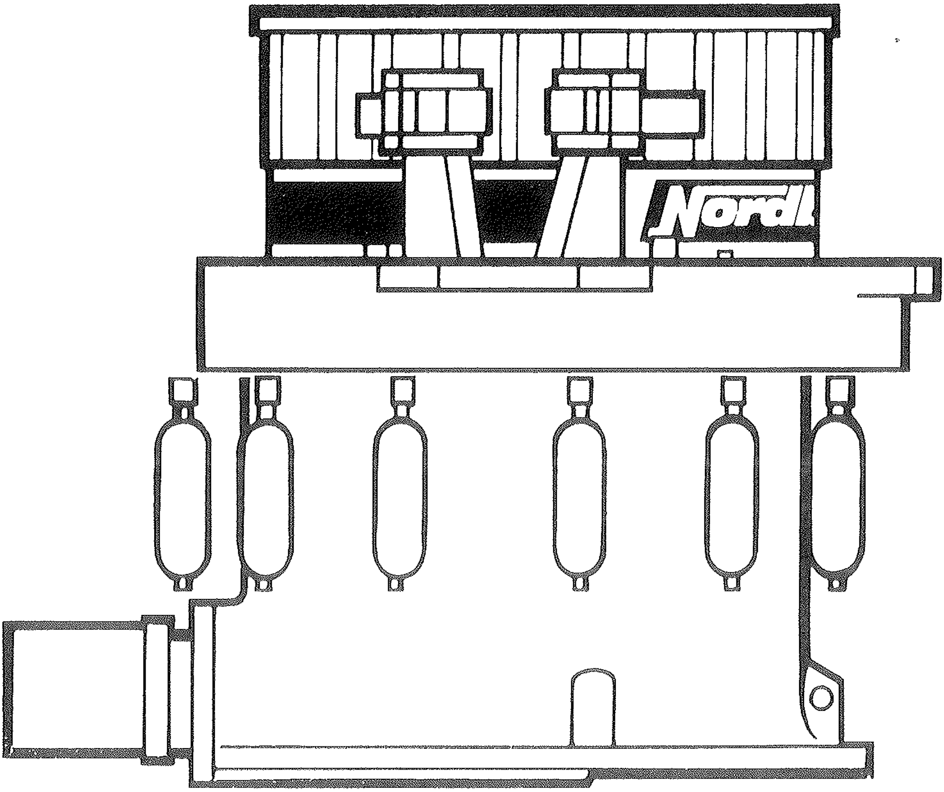
MP1000 Crushers



MP1000 GRADATIONS

FEED MATERIAL RATING - AVERAGE

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Closed Side Setting of Crusher, Inch							
	1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
4"								100
3"							100	91
2-1/2"						100	95	82
2"					100	93	86	70
1-1/2"				100	92	80	70	51
1-1/4"				95	82	70	57	41
1"			100	86	70	54	44	32
3/4"		100	92	70	51	39	32	25
1/2"	100	86	70	44	32	26	22	17
3/8"	94	70	51	32	25	20	17	13
1/4"	70	44	32	22	17	14	12	9
3/16"	50	32	25	17	13	11	9	7
No. 6	34	23	18	12	10	8	7	5
No. 8	25	17	13	9	7	6	5	4

*Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

MP1000 GRADATIONS

FEED MATERIAL RATING - AVERAGE

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Millimeters	Closed Side Setting of Crusher, Millimeters							
	6mm	10mm	13mm	19mm	25mm	32mm	38mm	51mm
102mm								100
76mm							100	91
64mm						100	95	82
51mm					100	93	86	70
38mm				100	92	80	70	51
32mm				95	82	70	57	41
25mm			100	86	70	54	44	32
19mm		100	92	70	51	39	32	25
13mm	100	86	70	44	32	26	22	17
10mm	94	70	51	32	25	20	17	13
6mm	70	44	32	22	17	14	12	9
5mm	50	32	25	17	13	11	9	7
3mm	34	23	18	12	10	8	7	5
2mm	25	17	13	9	7	6	5	4

*Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

MP1000 GRADATIONS

FEED MATERIAL RATING - HARD

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Inches	Closed Side Setting of Crusher, Inch							
	1/4"	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
4"								100
3"							100	92
2-1/2"						100	95	79
2"					100	94	84	60
1-1/2"				100	92	76	60	40
1-1/4"				95	79	60	46	30
1"			100	84	60	43	33	22
3/4"		100	92	60	40	29	22	16
1/2"	100	84	60	33	22	17	14	11
3/8"	92	60	40	22	16	13	11	8
1/4"	60	33	22	14	11	9	7	6
3/16"	40	22	16	11	8	7	6	4
No. 6	24	15	12	8	6	5	4	3
No. 8	16	11	8	6	4	4	3	2

*Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

MP1000 GRADATIONS

FEED MATERIAL RATING - HARD

Open Circuit Product Analysis* (% Passing) for Given Closed Side Setting of Crusher

Product Size Millimeters	Closed Side Setting of Crusher, Millimeters							
	6mm	10mm	13mm	19mm	25mm	32mm	38mm	51mm
102mm								100
76mm							100	92
64mm						100	95	79
51mm					100	94	84	60
38mm				100	92	76	60	40
32mm				95	79	60	46	30
25mm			100	84	60	43	33	22
19mm		100	92	60	40	29	22	16
13mm	100	84	60	33	22	17	14	11
10mm	92	60	40	22	16	13	11	8
6mm	60	33	22	14	11	9	7	6
5mm	40	22	16	11	8	7	6	4
3mm	24	15	12	8	6	5	4	3
2mm	16	11	8	6	4	4	3	2

*Note: These table values will vary with the method of feeding, selection of crusher cavity, the weight, cleanliness and moisture contents of the material and its fracture pattern. Accurate values should be established by actual testing.

MP1000 CONE CRUSHER CAPACITY CHARTS

Cone crusher capacity charts are developed for use as an application tool to properly utilize the machine's capabilities. MP1000 cone crushers have 3 separate and distinct capacities.

The difference between these is the point in the circuit at which the measure is taken in either open circuit or closed circuit operation. The crusher is one component of the circuit. As such, its performance is in part dependent on the proper selection and operation of feeders, conveyors, screens, supporting structure, electric motors, drive components and surge bins. Where used, attention to the following factors will enhance crusher capacity and performance.

1. Proper selection of crushing chamber for material to be crushed.
2. A feed grading containing proper distribution of the particle sizes.
3. Controlled feed rate.
4. Proper feed distribution 360 degrees around the crushing chamber.
5. Discharge conveyor sized to carry maximum crusher capacity.
6. Properly sized scalping and closed circuit screens.
7. Automation controls.
8. Adequate crusher discharge area.

The following factors will detract from crusher capacity and performance.

1. Sticky material in crusher feed.
2. Fines in crusher feed (smaller than crusher setting) exceeding 10% of crusher capacity.
3. Excessive feed moisture.
4. Feed segregation in crusher cavity.
5. Improper feed distribution around circumference of crushing cavity.
6. Lack of feed control.
7. Insufficient use of recommended connected horsepower.
8. Insufficient conveyor capacity.
9. Insufficient scalper and closed circuit screen capacities.
10. Insufficient crusher discharge area.
11. Extremely hard or tough material.
12. Operation of crusher at less than recommended full load countershaft speed.

Capacities shown are neither maximum nor minimum, and are based on results secured in actual practice. The figures shown apply to short tons of material weighing 100 pounds per cubic foot, and are based on a properly graded feed.

Note: To convert short tons to metric tons, multiply short tons by .907.

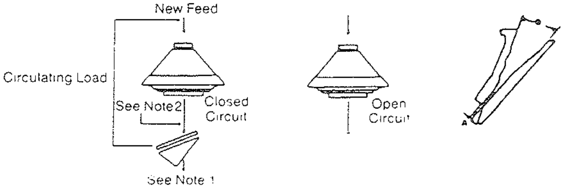
To determine effect of individual conditions, consult Nordberg.

MP1000 CONE CRUSHER CAVITY SELECTION

STANDARD CRUSHER	CAVITIES - FEED OPENINGS - PRODUCT SIZES - CAPACITIES											
OPEN CIRCUIT capacities in tons (2,000 lbs) per hour passing through the crusher at indicated discharge setting "A"	Type of Cavity	Recommended minimum discharge setting A	Feed opening with minimum recommended discharge setting A B Closed side	B Open side	5/8" (16mm)	3/4" (19mm)	7/8" (22mm)	1" (25mm)	1-1 1" (32mm)	1-1/2" (38mm)	2" (51mm)	2-1/2" (64mm)
	FINE	5/8" (16mm)	10-1/8" (253mm)	11-5/8" (291mm)	750	840	960	1100	1360	1600		
	MEDIUM	1" (25mm)	12-1/8" (303mm)	13-7/8" (347mm)				1340	1600	1780	2200	2600
	COARSE	1-1/4" (31mm)	13-3/8" (340mm)	15-1/4" (387mm)					1740	1860	2400	2800
	X-COARSE	1-1/2" (38mm)	16-3/4" (425mm)	18-5/8" (473mm)						1940	2600	3000

SHORT HEAD CRUSHER	CAVITIES - FEED OPENINGS - PRODUCT SIZES - CAPACITIES									
OPEN CIRCUIT capacities in tons (2,000 lbs) per hour passing through the crusher at indicated discharge setting "A"	Type of Cavity	Recommended minimum discharge setting A	Feed opening with minimum recommended discharge setting A B Closed side	B Open side	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	1" (25mm)
	FINE	1/4" (6mm)	2" (51mm)	4-5/8" (118mm)	600	720	800	900		
	MEDIUM	3/8" (10mm)	3-3/4" (95mm)	5-3/4" (146mm)		780	900	1000	1120	
	COARSE	1/2" (13mm)	5" (127mm)	7-1/2" (191mm)			1000	1060	1200	1320

CLOSED CIRCUIT capacities in tons (2,000 lbs) per hour based on closed operation	Type of Cavity	Recommended minimum discharge setting A	Feed opening with minimum recommended discharge setting A		Effective square opening on closed circuit screen													
					3/16" (5mm)		1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		1" (25mm)	
					Closed side settings for closed circuit operation													
					3/16" (5mm)		3/16" (5mm)		1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)	
			B Closed side	B Open side	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2
	FINE	1/4" (6mm)	2" (51mm)	4-5/8" (118mm)	240	480	320	480	480	720	630	780	720	900	840	1000		
	MEDIUM	3/8" (10mm)	3-3/4" (95mm)	5-3/4" (146mm)							630	840	720	1000	840	1100	1000	1200
	COARSE	1/2" (13mm)	5" (127mm)	7-1/2" (191mm)									760	1080	900	1300	1100	1320



Note 1 Net finished product (screen undersize)

Note 2 Tons per hour passing through crusher (net finished product plus recirculating load)

MP1000 CONE CRUSHER CAVITY SELECTION

STANDARD CRUSHER — CAVITIES - FEED OPENINGS - PRODUCT SIZES - CAPACITIES (METRIC TONS)

OPEN CIRCUIT capacities in metric tons (2,200 lbs) per hour passing through the crusher at indicated discharge setting "A"	Type of Cavity	Recommended minimum discharge setting A	Feed opening with minimum recommended discharge setting A — B Closed side	Feed opening with minimum recommended discharge setting A — B Open side	5/8" (16mm)	3/4" (19mm)	7/8" (22mm)	1" (25mm)	1-1/4" (32mm)	1-1/2" (38mm)	2" (51mm)	2-1/2" (64mm)
	FINE	5/8" (16mm)	10-1/8" (253mm)	11-5/8" (291mm)	680	762	871	998	1234	1452		
	MEDIUM	1" (25mm)	12-1/8" (303mm)	13-7/8" (347mm)				1216	1452	1615	1996	2359
	COARSE	1-1/4" (31mm)	13-3/8" (340mm)	15-1/4" (387mm)					1579	1687	2177	2540
	X-COARSE	1-1/2" (38mm)	16-3/4" (425mm)	18-5/8" (473mm)						1760	2359	2722

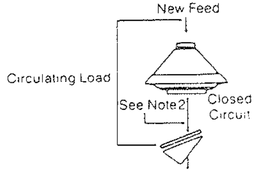
SHORT HEAD CRUSHER — CAVITIES - FEED OPENINGS - PRODUCT SIZES - CAPACITIES (METRIC TONS)

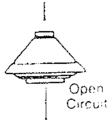
OPEN CIRCUIT capacities in metric tons (2,200 lbs) per hour passing through the crusher at indicated discharge setting "A"	Type of Cavity	Recommended minimum discharge setting A	Feed opening with minimum recommended discharge setting A — B Closed side	Feed opening with minimum recommended discharge setting A — B Open side	1/4" (6mm)	3/8" (10mm)	1/2" (13mm)	5/8" (16mm)	3/4" (19mm)	1" (25mm)
	FINE	1/4" (6mm)	2" (51mm)	4-5/8" (118mm)	544	653	726	916		
	MEDIUM	3/8" (10mm)	3-3/4" (95mm)	5-3/4" (146mm)		708	816	907	1016	
	COARSE	1/2" (13mm)	5" (127mm)	7-1/2" (191mm)			907	962	1089	1197

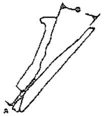
CLOSED CIRCUIT capacities in metric tons (2,200 lbs) per hour based on closed operation

Effective square opening on closed circuit screen (METRIC TONS)

Type of Cavity	Recommended minimum discharge setting A	Feed opening with minimum recommended discharge setting A — B Closed side	Feed opening with minimum recommended discharge setting A — B Open side	3/16" (5mm)		1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)		1" (25mm)	
			Closed side settings for closed circuit operation	3/16" (5mm)		3/16" (5mm)		1/4" (6mm)		3/8" (10mm)		1/2" (13mm)		5/8" (16mm)		3/4" (19mm)	
				NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2	NOTE 1	NOTE 2
FINE	1/4" (6mm)	2" (51mm)	4-5/8" (118mm)	218	435	290	435	435	653	572	708	653	816	762	907		
MEDIUM	3/8" (10mm)	3-3/4" (95mm)	5-3/4" (146mm)							572	762	653	907	762	998	907	1089
COARSE	1/2" (13mm)	5" (127mm)	7-1/2" (191mm)									689	980	816	1179	998	1197



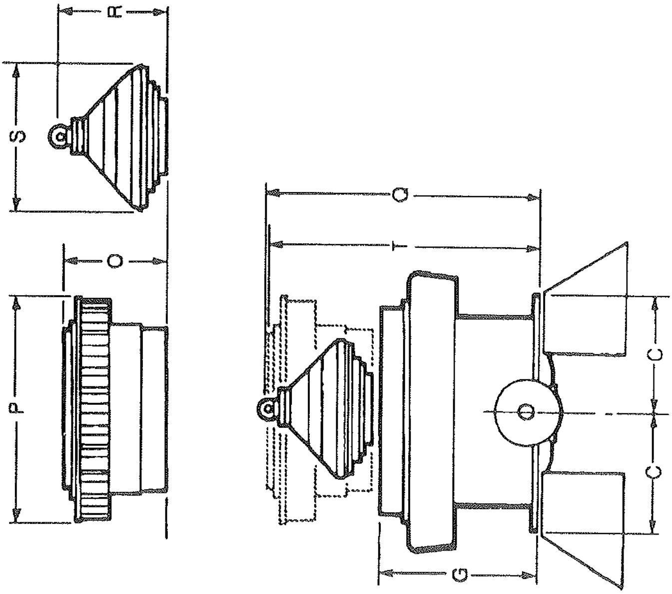


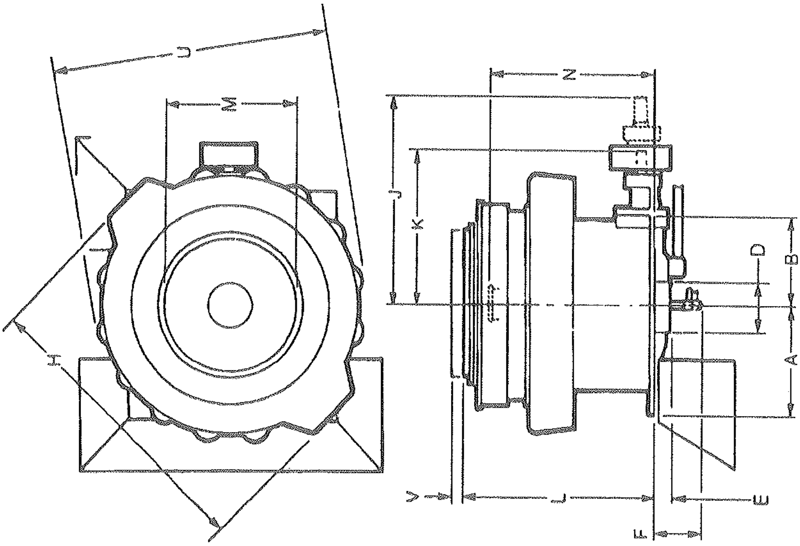


Note 1
Net finished product (screen undersize)

Note 2
Tons per hour passing through crusher (net finished product plus recirculating load)

MP1000 CLEARANCE DIMENSIONS





CLEARANCE DIMENSIONS
MP1000 CONE CRUSHER

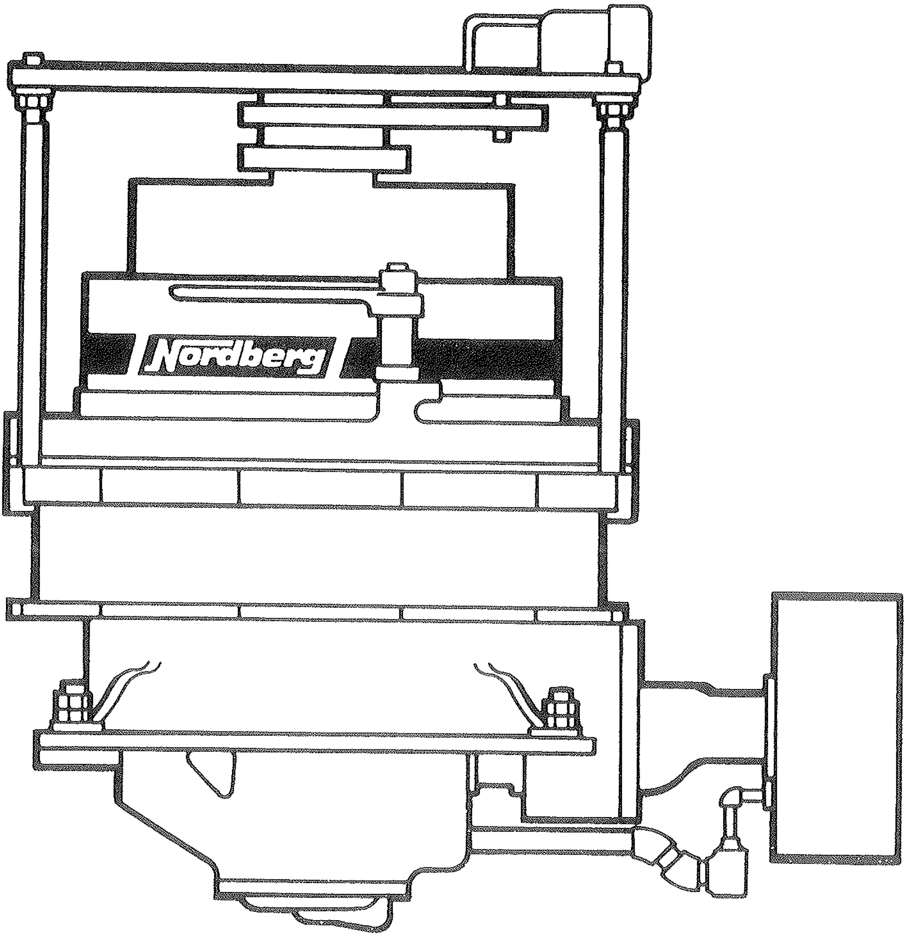
MP1000 Cone Crusher		STANDARD Feet (mm)	SHORT HEAD Feet (mm)
Crusher Centerline to Mainframe Flange	A & C	6'4-3/4" (1950)	6'4-3/4" (1950)
Crusher Centerline to Countershaft Housing Face	B	6'6-3/4" (2000)	6'6-3/4" (2000)
Main Frame Hub Diameter	D	3'2-3/8" (975)	3'2-3/8" (975)
Base to Bottom of Main Frame Hub	E	1'0-3/16" (310)	1'0-3/16" (310)
Base to Bottom of Oil Piping	F	2'7-7/8" (810)	2'7-7/8" (810)
Base to Top of Dust Collar	G	10'7-3/16" (3230)	10'7-3/16" (3230)
Adjustment Ring Maximum Diameter	H	16'4-1/16" (4980)	16'4-1/16" (4980)
Clearance Required for Removing Countershaft Assembly	J	14'1-5/16" (4300)	14'1-5/16" (4300)
Crusher Centerline to End of Countershaft	K	9'4-3/8" (2855)	9'4-3/8" (2855)
Maximum Height from Base to Top of Feed Hopper	L	13'7-1/4" (4146)	13'8-3/8" (4175)
Inside Diameter of Feed Hopper	M	8'3-5/8" (2530)	8'2-1/16" (2490)
Base to Top of Feed Plate	N	9'5-9/16" (2885)	9'5-9/16" (2885)
Overall Height of Bowl Assembly	O	7'2-1/16" (2186)	7'1-13/16" (2180)
Adjustment Cap Maximum Diameter	P	11'7-3/4" (3550)	11'7-3/4" (3550)
Clearance Required for Removing Bowl Assembly	Q	17'10-1/4" (5441)	17'10" (5435)
Overall Height of Head Assembly	R	6'9-7/8" (2080)	6'9-7/8" (2080)
Head or Mantle Maximum Diameter	S	7'10-3/16" (2392)	7'8-5/8" (2353)
Clearance Required for Removing Head Assembly	T	17'6-1/16" (5335)	17'6-1/16" (5335)
Tramp Release Side to Side	U	15'0-3/4" (4591)	15'0-3/4" (4591)
Additional Upward Travel Due to Clearing Stroke	V	5-15/16" (150)	5-15/16" (150)

STANDARD AND SHORT HEAD WEIGHTS

	MP1000	
	Kg.	Lbs.
Crusher Complete	135,730	299,150
Main Frame, Adjustment Ring, Clamping Ring, Clamping Cylinders, Tramp Release, Eccentric, Socket, Countershaft Box, Countershaft and Crusher Sheave	91,730	202,170
Main Frame, Adjustment Ring, Clamping Ring, Clamping Cylinders and Tramp Release	73,200	161,330
Main Frame, Including Main Shaft and Main Frame Liner	46,000	101,400
Bowl, Bowl Liner, Adjustment Cap and Hopper	28,000	61,700
Head, Mantle and Feed Plate	16,000	35,260
Countershaft Box, Countershaft and Crusher Sheave	3,200	7,050
Eccentric	9,820	21,640
Socket	630	1,390
Mantle	4,350	9,600
Bowl Liner	4,800	10,600

A Nordberg Group Company

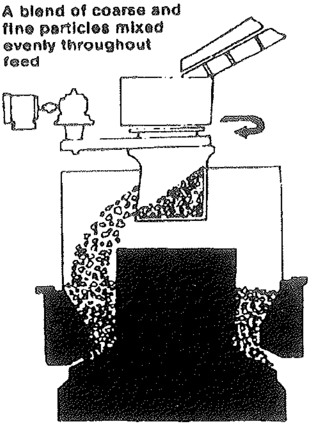
Gyradisc Crushers



GYRADISC CRUSHER APPLICATION INFORMATION

Interparticle comminution — defined
In the Gyradisc crusher a fine product is produced by a combination of impact and attrition of a multilayered mass of particles. This process of crushing is termed "interparticle comminution." Here's how it works.

Proper feed and uniform feed distribution — a must
A homogenous mix of coarse and fine particles is constantly fed to the crusher so that a head of material is developed and maintained within the crusher. Incoming feed, at the center of the crushing cavity, is spread radially outward to the perimeter of the surge chamber by a motorized rotating feed distributor. The descending velocity of the incoming material is reduced by the feed distributor and the feed is lightly deposited, in a circular path, layer upon layer. The particles within the feed mass are separated by a countless number of voids created by the loose layering of feed particles.



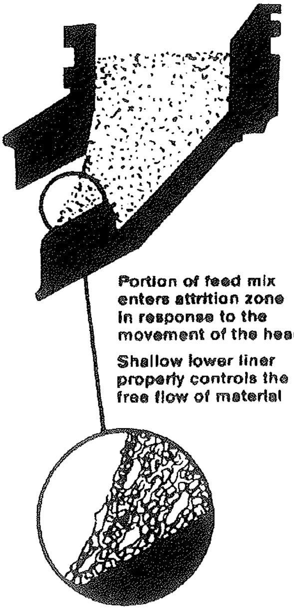
Proper feed distribution with motorized feed distributor

The independently powered feed distributor working with a controlled rate of feed completely satisfies the four basic requirements necessary for optimum performance in the process of interparticle comminution. These four necessary elements are:

1. A satisfactory volume of voids which prevent packing.
2. A homogenous mix of coarse and fine particles.
3. A uniform distribution of feed around the cavity (surge chamber).
4. A constant maintenance of a head of material in the surge chamber.

The importance of metered feeding
Each time the lower liner moves away from the upper liner a portion of the feed mix enters the attrition chamber from the surge load above. The flat angle of the lower liner is **less than the angle of repose** of the material undergoing reduction. If the lower liner were at rest the material delivered to the attrition chamber would not of itself slide downward through the chamber. The shallow liner angle offers enough resistance to the flow of material, by gravity, that it is only the motion of the head which advances the material **outwardly** a slight amount at each gyration. The movement of material through the attrition chamber is **positive** in response to the carrying movement of the head. In other words, the motion of the gyrating head and the pressure due to the height of the surge capacity in the cavity causes the material undergoing reduction to move progressively outward through the attrition chamber in a series of short steps. The passage of material through the attrition chamber is not continuous but intermittent. Somewhat like the

introduction of fuel in an internal combustion engine, the Gyradisc crusher advances the feed material only prior to the power stroke. **Because of the number of gyrations and cavity design, the percentage of oversize product is greatly reduced and highly efficient crushing takes place.**



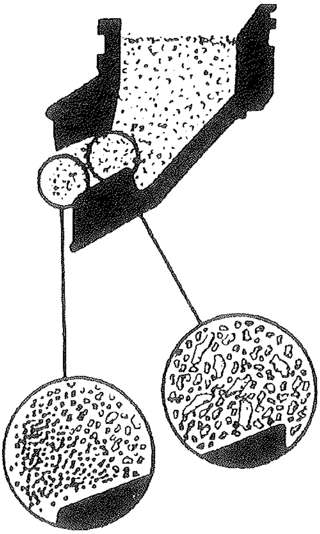
Impact with attrition — the most efficient crushing

When reduction begins, the material is picked up by the lower liner, moved outwardly and caught between the crushing members. The impact of the head results in reduction of material by grinding and by fracture of particle-upon-particle caused by forceful relocation of the particles within the mass. Even at the closest approach of the attrition members, the liners are still separated by a layer of small particles of substantial thickness. In most instances, it has been found that a better product and greater usable quantity of desired size is obtained by increase rather than decrease of gap when it becomes a question of optimizing machine capacity and power draw. **Therefore, the setting of the crushing members is not as directly related to the size of the product required as is the setting in the cone-type crusher.**

Remember that during the upward thrust of the rotating head two distinct processes combine to reduce the feed into a uniform fine product:

1. The impact of coarse particle against fine particle similar to the action of balls or pebbles in a grinding mill.

The progressive structuring of cubical shaped, fine particles is clearly shown in these two enlarged views of the attrition zone



Finely crushed particles are discharged at perimeter of attrition chamber

2. The attrition resulting from the high surface friction during forceful relocation of the particles into

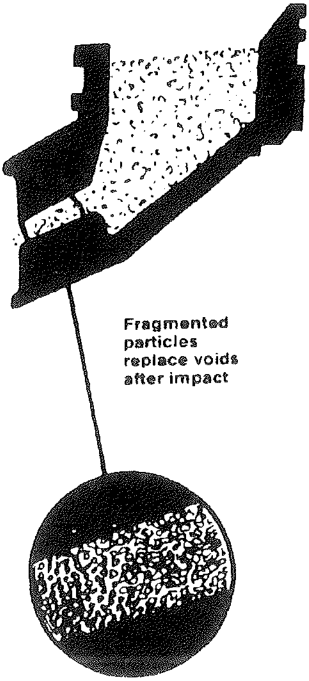
smaller voids within the feed mass. In the Gyradisc crusher, the combination of impact and attrition offers the most efficient power utilization as compared to other fine crushing or reduction methods employed today.

Predetermined stroke and timed rotation — consistent uniformity of cubical shaped product

At each recession of the head the void left at the throat is filled by particles flowing in from the surge chamber. This procedure is repeated until the particles at the periphery of the attrition chamber are discharged. With each succeeding gyration, the length of stroke and timing of the movement of the head are such that the lower liner is withdrawn faster than the free fall velocity of the previously crushed mass. Since the speed of descent is relatively slow at the beginning of the fall, the speed of gyration can be timed so that a half revolution of the head can be made before the crushed material falls any appreciable distance. This permits the lower liner to recede and return to hit the previously crushed mass as it is falling, scattering it so that a new alignment of particles is obtained prior to another impact. This reorientation of the particles at each impact results in a high degree of uniformity in both size and shape and produces a cubical shaped product.

In recent years many attempts have been made to copy the Nordberg Gyradisc crusher principle of interparticle comminution with little or no success. In designing the Nordberg Gyradisc crusher a total concentration of effort was devoted to matching machine to job. The Nordberg Gyradisc crusher is the only crusher exclusively designed to support the magnitude and direction of the forces encountered during interparticle comminution.

Others have merely modified the crushing cavities on existing cone crushers. This less than total effort has met with poor performance and numerous structural failures.



OPERATOR'S BENEFITS

Manufactured sand — a rapidly expanding market
Manufactured sand is a construction material produced by crushing or grinding, screening and classifying rock or gravel to meet specifications set forth by ASTM, Federal and State highway departments and the U.S. Army Corps of Engineers. **The demand for economical and efficient sand producing machinery has grown as natural sand deposits diminish.**

Cubical shaped sand — a more marketable product
The ability of the Gyradisc crusher to consistently produce a cubical shaped product is no design accident. Structuring sand particles into cubical shape, requires precise timing between impact, feed advancement, particle arrangement, and proper reduction ratio. **Cubical shaped sand, in batch mixes, makes a superior concrete or asphalt, is a more marketable product and offers cost saving benefits.**

Concrete — Manufactured sand produced in a Gyradisc crusher is preferred because the cubical particle shape not only contributes **more strength** to the concrete, but results in **further savings** because less cement is required. Independent tests have proved that the more cubical the aggregate and the lower the proportion of flaky and elongated particles, the more acceptable the material will be from the mix design aspect. Natural sands have a tendency to have rounded corners and consequently produce a concrete which is not quite as strong as concrete using manufactured sand.

Asphalt — Gyradisc manufactured sand produces a **stronger** and **more stable** mixture for asphalt because of the **interlocking** of angular aggregate particles, while the surface of the cubical crushed particle provides greater area for the volume occupied than the round particle. This permits cementing the particles together with asphalt and reduces the possibility of displacement.

Operating cost — minimal
Gyradisccrusheroperating-at-cost-per-ton of sand includes liners, maintenance, and power draw. The liner cost is related to the abrasive characteristics of the material being crushed and the surface moisture. Average liner costs are between $.07 and $.09 per ton of sand. Proper maintenance, excluding liners, will result in costs not exceeding $.03 per ton. Power consumption will be in the area of 3 kwh per ton of sand.

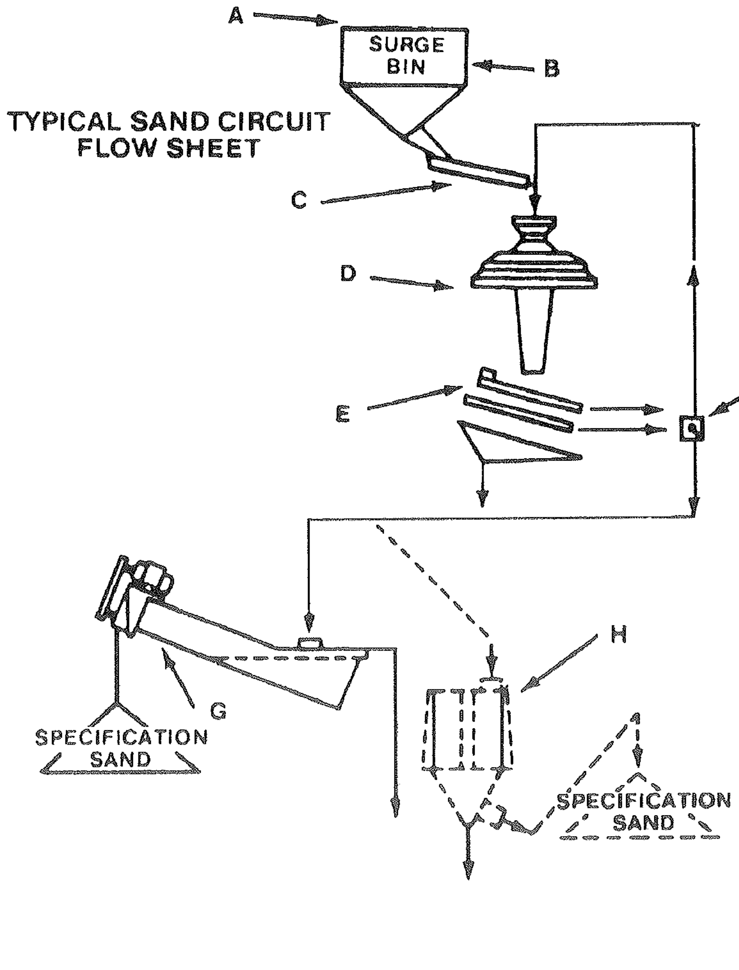
Gyradisc sand — a better sand at less cost
Prior to the development of the Gyradisc crusher, manufactured sand was produced by rod mills, impact crushers, and roll crushers. **In comparing all these methods of sand production, with the Gyradisc crusher, they all fall short. Here's why:**

Rod mill — The rod mill is capable of producing fines, but **the power and metal cost** and the tendency to produce an **excess of extreme fines** are the principal factors that contribute to the relatively high final cost of rod mill sand.

Impact crushers — Impact crushers develop **high wear rates** when crushing abrasive materials and also normally create an **excess of extreme fines**. Most specifications permit only 2 to 10 percent passing a No. 100 sieve, any excess produced in this range must be removed.

Roll crushers — Roll crushers, on the other hand, have **difficulty in producing a sufficient quantity of fines in the 30, 50 and 100 sieve sizes.** Roll shell wear contributes to **size control problems** and develops **high circulating loads.**

MANUFACTURED SAND
TYPICAL SAND CIRCUIT



Producing Gyradisc sand in a typical sand circuit

For a successful sand producing circuit, the material flow should be as shown in the flow sheet on page 10-5. An explanation of the devices and their purpose in the circuit are given in their functional sequence.

A. **Prescreening** — In a typical sand producing circuit new feed is prescreened on a No. 4 opening screen. Feed should be prepared before it enters the Gyradisc crusher surge bin. As much free water as practical should be removed. There are several Nordberg screens which are well suited for dewatering.

B. **Surge Bin** — The prepared feed enters a surge bin of sufficient capacity to sustain continuous full load operation. The size of the surge bin is related to the efficiency or continuity of the new feed rate entering the sand circuit. Normally, however, the bin sizes should be at least 20 ton live storage for the 36" and 48", and 40 ton for the 66" and 84" sizes.

C. **Feeder** — A vibrating feeder or variable speed conveyor belt takes new feed from the surge bin and delivers it to the crusher.

D. **Gyradisc Crusher** — The feed enters the crusher where it is reduced into cubical shaped particles. To minimize the reaction time between the control point (feeder) and the Gyradisc crusher, it is recommended that the crusher be located as close to the bin and feed as practical. This circuit arrangement is well suited for automation or efficient manual control.

E. **Screening** — The crushed product should be screened on a double deck dry screen like the Nordberg sizing screen. The exact sizes of the screen openings will vary and are dependent on the crushing characteristics of the materials and the final specification. Usually a cloth having a No. 4 opening is used on the top deck and No. 8, 10 or 12 is used on the bottom deck.

F. **Flop Gate** — The Flop gate regulates the amount of between deck material that is returned to the Gyradisc crusher. The correct percentage of material passing the top or bottom deck screen can be controlled by adjusting the flop gate to increase or decrease the recirculating load. Note the method of returning the circulating load to the Gyradisc crusher. Bypassing the surge bin eliminates size segregation in the bin and increases the effective surge capacity.

G. **Classifier** — Excess fines (passing No. 100) are removed through the use of a hydraulic classifier.

H. **Separator** — An air separator can be employed when the disposal of tailing is difficult, when water is unavailable, or where a market exists for excess fines in the form of mineral filler.

An alternate sand circuit would involve producing a screen undersize consisting entirely of a minus No. 6 or No. 8 Gyradisc crusher product. This arrangement, however, does not have the built-in flexibility available in the specification sand circuit shown in the typical flow sheet (see page 10-5).

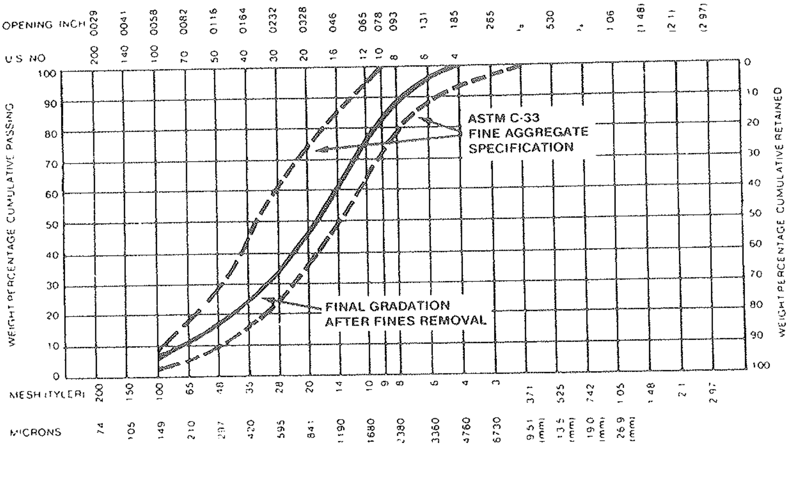
These two charts show the results of a test conducted, with the Gyradisc Crusher circuit in balance, comparing minus No. 4 screen undersize with ASTM C-33 Specification Sand.

CUMULATIVE PERCENT PASSING

Sieve Size	Test run of minus No. 4 from Gyradisc Crusher circuit	Correction by returning portion of bottom deck oversize (No. 10) to Gyradisc Crusher	Final sand after fines removal	Percent (retained) for fineness modulus calculation	ASTM C-33 Specification Sand
3/8" (9mm)	100	100	100		100
No. 4	100	100	100		95-100
No. 8	75	92	91	9	80-100
No. 16	53	64	60	40	50-85
No. 30	35	41	34	66	25-60
No. 50	23	27	19	81	10-30
No. 100	14	17	8	92	2-10

FINENESS MODULUS 2.88 = 288/100 = 2.88 (LIMITS 2.3 - 3.1)

STANDARD SCREEN ANALYSIS



MANUFACTURED SAND SCREEN ANALYSIS

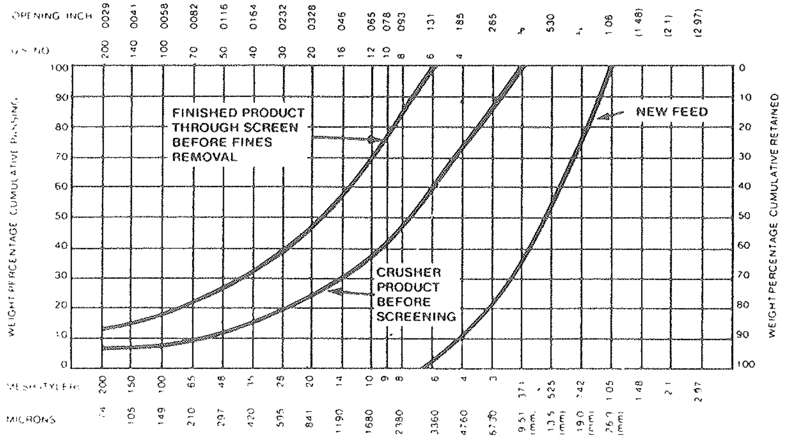
FEED: LIMESTONE
PRODUCT: MANUFACTURED SAND

The following charts show typical sand circuit gradations for limestone, granite, gravel, iron ore, and copper ore.

Sieve Size (Inches)	Mesh (Tyler)	U.S. No.	Cumulative Percent Passing		
			New Feed	Crusher Product Before Screening	Finished Product Through Screen
1.48 (38mm)					
1.06 (27mm)			98		
.742 (19mm)			75		
.525 (13mm)			50	100	
.371 (9mm)			30	98	
.263 (7mm)	3		22	87	
.185 (5mm)	4	4	10	73	
.131 (3mm)	6	6	1	58	100
.093 (2mm)	8	8		46	88
.065 (1.6mm)	10	12		37	72
.046 (1mm)	14	16		30	58
.0328 (.833mm)	20	20		24	46
.0232 (.589mm)	28	30		20	38
.0164 (.416mm)	35	40		17	31
.0116 (.294mm)	48	50		14	26
.0082 (.208mm)	65	70		12	22
.0058 (.147mm)	100	100		10	18
.0041 (.104mm)	150	140		8	14
.0029 (.073mm)	200	200		7	11

Note: Finished product through screen refers to the sand before fines removal. The procedure for obtaining the final specification sand is shown in the Sand Circuit diagrams and the Test Results charts.

STANDARD SCREEN ANALYSIS



MANUFACTURED SAND SCREEN ANALYSIS

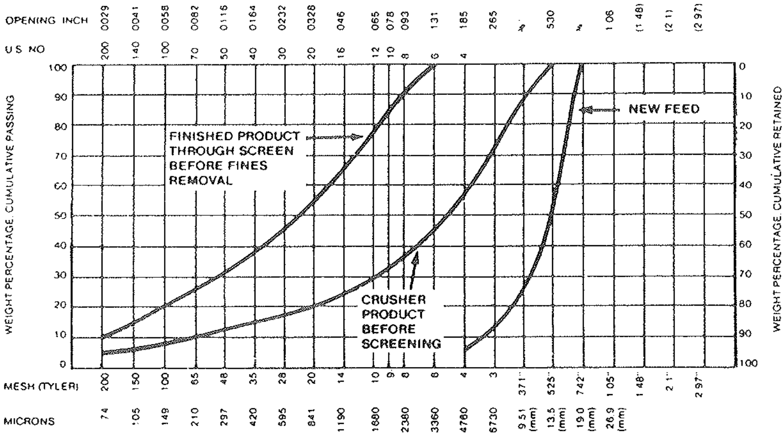
FEED: GRANITE
PRODUCT: MANUFACTURED SAND

The following charts show typical sand circuit gradations for limestone, granite, gravel, iron ore, and copper ore.

Sieve Size (Inches)	Mesh (Tyler)	U.S. No.	Cumulative Percent Passing		
			New Feed	Crusher Product Before Screening	Finished Product Through Screen
1.48 (38mm)					
1.06 (27mm)					
.742 (19mm)			100		
.525 (13mm)			51	100	
.371 (9mm)			22	92	
.263 (7mm)	3		12	72	
.185 (5mm)	4	4	5	57	
.131 (3mm)	6	6	1	46	100
.093 (2mm)	8	8		37	94
.065 (1.6mm)	10	12		30	77
.046 (1mm)	14	16		25	63
.0328 (.833mm)	20	20		21	53
.0232 (.589mm)	28	30		18	46
.0164 (.416mm)	35	40		16	39
.0116 (.294mm)	48	50		13	32
.0082 (.208mm)	65	70		11	26
.0058 (.147mm)	100	100		8	20
.0041 (.104mm)	150	140		6	14
.0029 (.073mm)	200	200		5	10

Note: Finished product through screen refers to the sand before fines removal. The procedure for obtaining the final specification sand is shown in the Sand Circuit diagrams and the Test Results charts.

STANDARD SCREEN ANALYSIS



STANDARD SCREEN ANALYSIS

Blend sand is used to make up the deficiencies in sand specifications often found in natural sand deposits and crusher screenings. Grading deficiencies vary, but generally are in the No. 16, 30 and 50 size ranges. Mixing a blend sand that has a high percentage of normally deficient sizes with natural sands will result in a properly graded sand. The precise mixture of blend sand to natural sand varies in each installation and depends on the natural sand deposit.

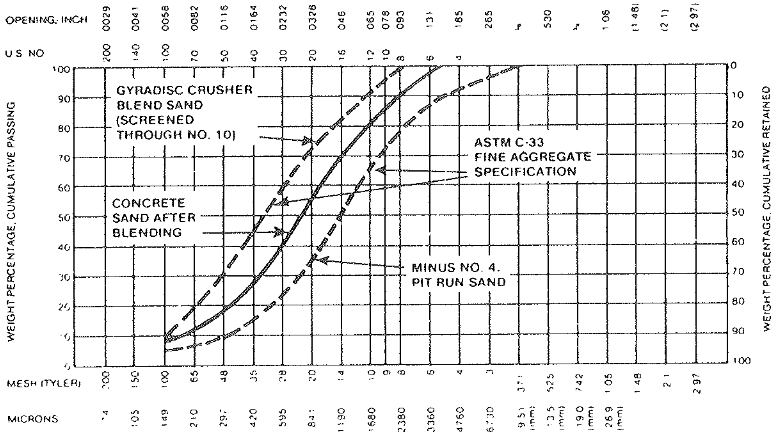
The ability of a Gyradisc Crusher to maintain constant product analysis in a closed circuit operation makes it ideally suited for the production of blend sand. Uniform product analysis is important in sand production because the allowable variation in the fineness modulus frequently is no more than 0.15. Gyradisc feed is usually a minimum 1/2" prescreened at the closed circuit screen opening. Screening is dry with the opening normally at No. 8, 10 or 12.

FEED: GRAVEL PRODUCT: BLEND SAND

Sieve Size (U.S. NO.)	CUMULATIVE PERCENT PASSING					
	Minus No. 4 Pit Run Sand	Gyradisc Crusher Feed	Gyradisc Crusher Product	Screened Through No. 10	Concrete Sand After Blending	ASTM C-33 Specification Sand
3/8" (9mm)		100	100		100	100
No. 4	100	84.5	92		99	95 - 100
No. 8	74.5	42.6	69	100	93	80 - 100
No. 10		29.7	60	99.5		
No. 16	46	10.2	43	90.5	70	50 - 85
No. 30	27	4.7	28	60.5	40.6	25 - 60
No. 40			21	50.2		
No. 50	11	3.4	18	37	18	10 - 30
No. 80			12	26.5		
No. 100	1.5		10	20.5	8	2 - 10
No. 200			6	11.4	3	0 - 5
Fineness Modulus	3.4		3.36	1.96	2.7	

Note: The blending ratio in the example above is one part natural sand to one part manufactured sand.

STANDARD SCREEN ANALYSIS

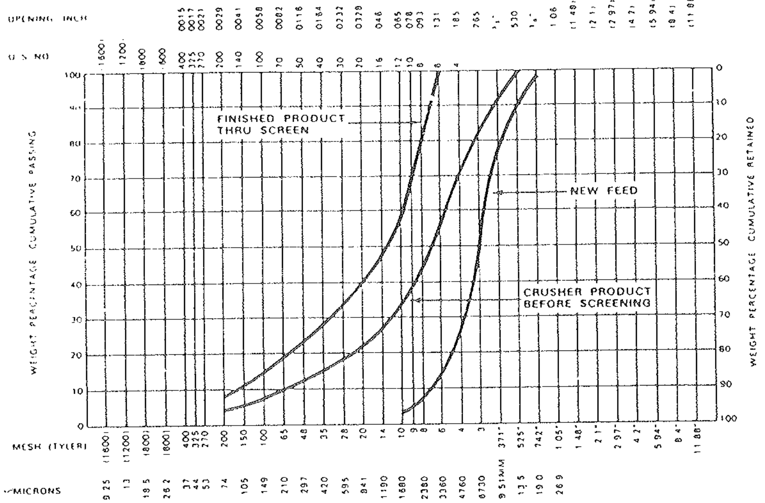


STANDARD SCREEN ANALYSIS

FEED: IRON ORE
PRODUCT: BALL MILL FEED

Sieve Size (Inches)	Mesh (Tyler)	U.S. No.	Cumulative Percent Retained		
			New Feed	Crusher Product Before Screening	Finished Product Through Screen
1.48 (38mm)					
1.06 (27mm)					
.742 (19mm)			1		
.525 (13mm)			8		
371 (9mm)			21	8	
.263 (7mm)	3		49	16	
.185 (5mm)	4	4	72	27	
.131 (3mm)	6	6	84	42	
.093 (2mm)	8	8	92	55	19
.065 (1.6mm)	10	12	97	65	39
.046 (1mm)	14	16		72	52
.0328 (.833mm)	20	20		77	59
.0232 (.589mm)	28	30		81	65
.0164 (.416mm)	35	40		85	70
.0116 (.294mm)	48	50		87	75
.0082 (.208mm)	65	70		90	80
.0058 (.147mm)	100	100		92	85
.0041 (.104mm)	150	140		94	89
.0029 (.073mm)	200	200		96	92

STANDARD SCREEN ANALYSIS

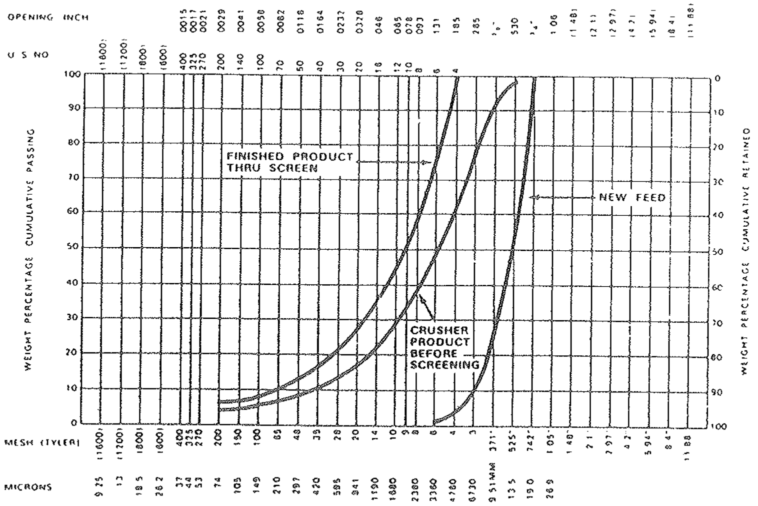


STANDARD SCREEN ANALYSIS

FEED: COPPER ORE
PRODUCT: BALL MILL FEED

Sieve Size (Inches)	Mesh (Tyler)	U.S. No.	Cumulative Percent Retained		
			New Feed	Crusher Product Before Screening	Finished Product Through Screen
1.48 (38mm)					
1.06 (27mm)					
.742 (19mm)					
.525 (13mm)			47	1	
.371 (9mm)			81	7	
.263 (7mm)	3		91	21	
.185 (5mm)	4	4	97	36	
.131 (3mm)	6	6	99	51	19
.093 (2mm)	8	8		62	42
.065 (1.6mm)	10	12		71	55
.046 (1mm)	14	16		77	64
.0328 (.833mm)	20	20		83	73
.0232 (.589mm)	28	30		86	78
.0164 (.416mm)	35	40		89	83
.0116 (.294mm)	48	50		92	88
.0082 (.208mm)	65	70		93	89
.0058 (.147mm)	100	100		95	92
.0041 (.104mm)	150	140		96	94
.0029 (.073mm)	200	200		97	95

STANDARD SCREEN ANALYSIS



CAPACITY TABLE

CAPACITY TABLE BASED ON CLOSED CIRCUIT OPERATION

Gyradisc Crusher Designation English	Metric	Head Dia. Inches (Millimeters)	Capacity 1 Total TPH Through Crusher	Capacity 2 in Tons (2000 Lbs.) Per Hour (Screen Undersize) (Metric Tons) — Recommended Screen Size: .375" (9mm)	.250" (6mm)	.185" (5mm) US #4 4 Mesh	.131" (3mm) US #6 6 Mesh	.093" (2mm) US #8 8 Mesh	.065" (1.6mm) US #12 10 Mesh	.046" (1mm) US #16 16 Mesh	.0328" (.833mm) US #20 20 Mesh	ASTM C 33 Spec Sand
36" GD	900 GD	36" (914mm)	65-75	60 (54) 4'x12'SD	50 (45) 4'x12'SD	35 (32) 4'x14'SD	30 (27) 5'x14'DD	23 (21) 5'x14'DD	18 (16) 6'x14'DD	15 (14) 6'x20'DD	10 (9) 6'x20'DD	20 25
48" GD	1200 GD	48" (1219mm)	115-130	105 (95) 4'x12'SD	80 (72) 5'x14'SD	55 (50) 6'x16'SD	45 (41) 6'x20'DD	40 (36) 6'x20'DD	30 (27) 8'x20'DD	25 (23) 8'x20'DD	17 (15) 2 Req 6'x16'DD	34 40
66" GD	1650 GD	66" (1676mm)	190-210	160 (145) 5'x12'SD	120 (109) 6'x20'SD	85 (77) 8'x20'SD	70 (63) 2 Req 6'x16'DD	60 (54) 2 Req 6'x16'DD	45 (41) 2 Req 6'x20'DD	40 (36) 3 Req 6'x16'DD	25 (23) 2 Req 8'x20'DD	55-60
84" GD	2100 GD	84" (2134mm)	265-300	250 (226) 6'x14'SD	180 (163) 8'x20'SD	130 (118) 2 Req 6'x20'DD	100 (91) 2 Req 6'x20'DD	90 (82) 2 Req 6'x20'DD	70 (63) 2 Req 8'x20'DD	60 (54) 2 Req 8'x20'DD	40 (36) 4 Req 6'x16'DD	70-80

Capacities shown are neither maximum nor minimum, and are based on results secured in actual practice. The figures shown apply to short tons of material weighing 100 pounds per cubic foot, and are based on a properly graded feed with the crusher consuming a minimum of 80% of the recommended horsepower. A feed size of minus 3/4" is typical, but a minus 1-1/2" feed can be readily accepted.

Optimum capacity is obtained with a closed side setting ranging between 1/4" and 1/2". The setting is not necessarily related to the closed circuit screen opening.

Factors which may affect capacity include, size of feed, friability, toughness and moisture content.

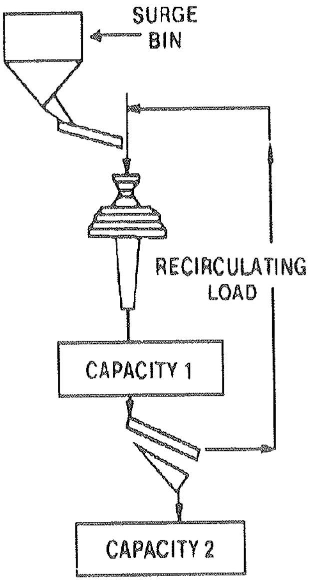
Figures shown under column "TPH THROUGH CRUSHER" are included for calculating screen areas.

For finer product requirements, contact Nordberg.

The recommended screening areas were determined using the crusher product screen analysis.

SD and DD signifies single deck and double deck screens.

CLOSED CIRCUIT

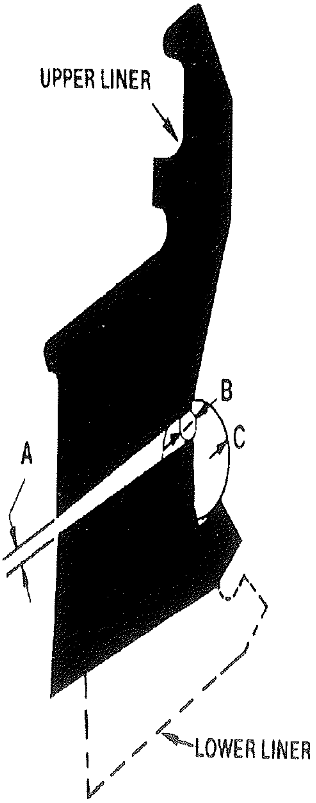


CRUSHING CAVITY

The crusher liners which comprise the Gyradisc cavity design are made up of an upper liner which is assembled to the bowl and a lower liner which is mounted on the head or main shaft assembly. Due to the wide range of feed and product requirements, the availability of variations in cavity design becomes an important factor in a successful Gyradisc operation.

Based on the feed and product requirements the throat opening designed as "B" in the diagram to the right is effected by the proper grinding of the liners. The reduction ratio per gyration is shown by comparing the open side dimension "C" with the closed side throat opening "B". The closed side setting designated as "A" is normally between 1/4" and 1/2" even when producing fine products in closed circuit below U.S. No. 8.

With coarse feed in the range of 1-1/2" to 4" and for coarse aggregate requirements above U.S. No. 4 the throat opening "B" would be modified to permit entry of the feed into the attrition zone in sufficient volume to draw the design horsepower. This type of operation requires settings up to 1". Refer to table below.

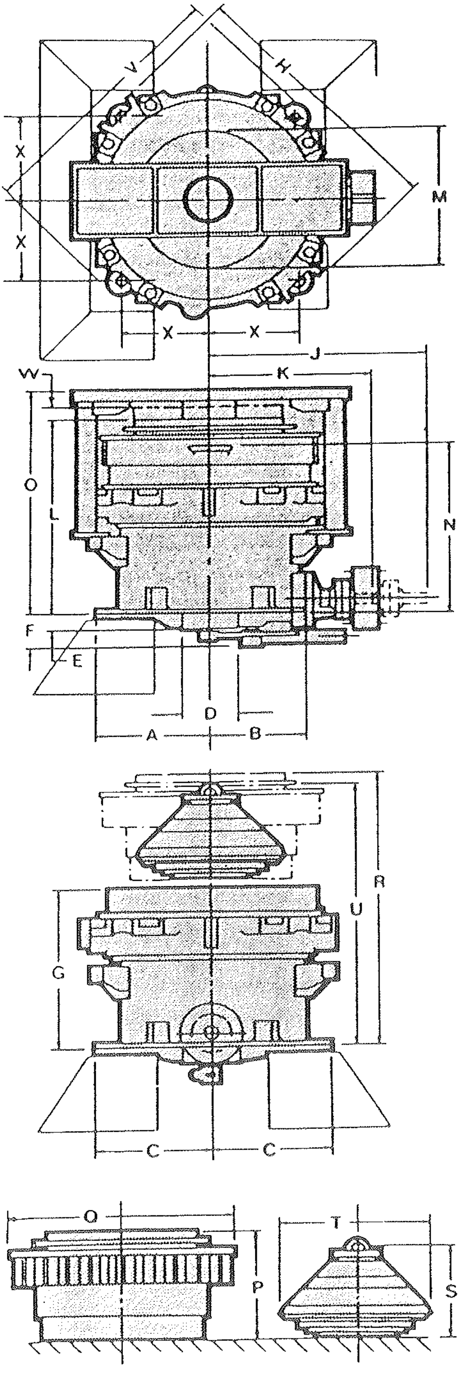


MAXIMUM RECOMMENDED FEED SIZES IN INCHES (MILLIMETERS) 100% PASSING SQUARE SCREEN OPENING

	Gyradisc Crusher Size			
	36" (900mm)	48" (1200mm)	66" (1650mm)	84" (2100mm)
For Products in Open Circuit or Shaping Materials	1-1/2" (38mm)	2" (51mm)	3" (76mm)	4" (102mm)
For Products (Minus 0.250) in Closed Circuit	1-1/4" (32mm)	1-1/2" (38mm)	2" (51mm)	3" (76mm)
For Manufactured Spec. Sand	3/4" (19mm)	1" (25mm)	1-1/4" (32mm)	1-1/2" (38mm)

Note: Crusher throughput will be reduced when operating in open circuit or with very coarse feed.

CLEARANCE DIMENSIONS



GYRADISC CRUSHER SPECIFICATIONS

Dimensions - Weights - Horsepower

GYRADISC CRUSHER DESIGNATION		HEAD DIAMETER	A	B	C	D
ENGLISH	METRIC					
36" GD	900 GD	36" (914mm)	6'-11.50" (2121mm)	11'-0.50" (3366mm)	3'-5.375" (1051mm)	7'-4.125" (2238mm)
48" GD	1200 GD	48" (1219mm)	8'-3.785" (2537mm)	13'-3.00" (4039mm)	4'-3.50" (1308mm)	8'-8.50" (2654mm)
66" GD	1650 GD	66" (1676mm)	9'-9.250" (2977mm)	12'-5.75" (3804mm)	5'-0.75" (1543mm)	10'-8.875" (3324mm)
84" GD	2100 GD	84" (2134mm)	11'-11.50" (3645mm)	17'-6.375" (5344mm)	5'-10.875" (1800mm)	12'-4.625" (3775mm)

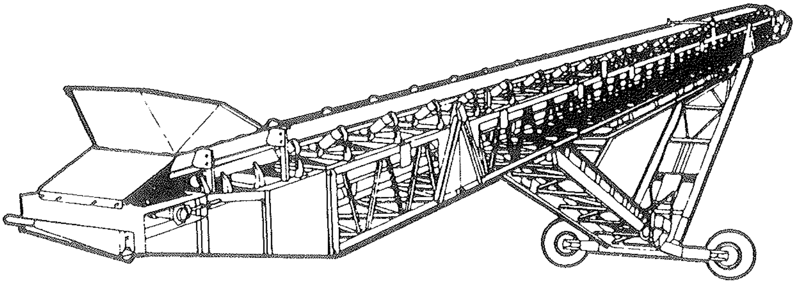
GYRADISC CRUSHER DESIGNATION		HEAD DIAMETER	E	F	G	H
ENGLISH	METRIC					
36" GD	900 GD	36" (914mm)	4'-8.00" (1422mm)	2'-3.00" (686mm)	1'-9.50" (546mm)	1'-9.25" (540mm)
48" GD	1200 GD	48" (1219mm)	5'-5.50" (1664mm)	2'-10.50" (876mm)	2'-7.44" (799mm)	2'-3.00" (686mm)
66" GD	1650 GD	66" (1676mm)	8'-1.00" (2464mm)	3'-4.50" (1028mm)	2'-7.25" (793mm)	2'-7.50" (800mm)
84" GD	2100 GD	84" (2134mm)	9'-8.625" (2962mm)	4'-5.25" (1353mm)	3'-4.50" (1029mm)	2'-11.50" (902mm)

GYRADISC CRUSHER DESIGNATION		HEAD DIAMETER	J	RECOMMENDED HORSEPOWER ELECTRIC	WEIGHT LBS.	COUNTER-SHAFT SPEED
ENGLISH	METRIC					
36" GD	900 GD	36" (914mm)	4'-4.00" (1321mm)	100	24,400	650
48" GD	1200 GD	48" (1219mm)	5'-9.50" (1765mm)	200	58,800	590
66" GD	1650 GD	66" (1676mm)	7'-5.00" (2260mm)	300	97,200	540
84" GD	2100 GD	84" (2134mm)	8'-2.00' (2489mm)	400	168,000	525

Nordberg®

A Nordberg Group Company

Conveyors and Idlers



GENERAL INFORMATION

General application questions

The physical arrangement of the conveyor must be described through some combination of these dimensions:

* length between the pulley centers
* angle of incline
* vertical lift
* horizontal dimension between pulley centers.

What is the typical Tons Per Hour the conveyor will handle? What is the TPH of the surges expected to be?

Does the user expect to increase the TPH or increase the length of the conveyor in the foreseeable future? What are the conveyor belt width and/or belt speed preferences?

What is the bulk density of the material?

What is the maximum lump size expected? What percentage of the material will be lumps of that size: 10%, 50%, 100%?

How is the conveyor to be fed: chute, feeder, another conveyor, loader, dozer?

Is there more than one feed point?

What is the drop height onto the feed points?

What type of transfer points are there? Conveyors that feed stackers or feed conveyors that change the direction of flow should have discharge hoods. A material deflector may be needed at transfer points along the conveyor, such as recirculating circuit.

Will there be any additional skirt board beyond the 5' of the standard receiving hopper?

Is reversing required?

How many hours per day will the conveyor operate?

Is the application more than 3,300 feet above sea level?

Will the conveyor be repeatedly started and stopped with product on the belt, such as in a loadout operation?

What type idlers are desired:
4", 5" or 6" diameter?
Ball or roller bearings?
Sealed or regreasable bearings?

Is there some minimum belt ply count, PIW rating, or cover thickness requirement?

What accessories are required?

Specific questions for stationary conveyors

Is truss frame or channel frame preferred?

Are there obstructions to clear or minimum span distance requirements?

Is there a vertical curve in the frame?

If Nordberg is providing the conveyor supports:
Is the head end support from grade or from structure?
Is the site surface uniform and level?

Specific questions for stackers

What kind of mobility is required:
None, permanent runway,
Mobility within a plant site,
Over-the-road portability?

NORDBERG CONVEYORS GENERAL INFORMATION
(continued)

What kind of towing means is required:
Ring tow hitch bolted to foot terminal,
5th wheel kingpin for truck tractor?

What kind of boom adjustment and raising means:
None -- fixed incline @____ degrees,
Lift & pin with raising by external means,
Hand powered hydraulic pump,
Electric motor driven hydraulic pump?

Potential Pitfalls

Belt speed - Others thing being equal, reducing the belt speed will require shafts, bearings and gear reducers heavier than would normally be required. Increasing belt speed will require more horsepower. It is important to consult the factory when non-standard belt speeds are anticipated.

Angle of operation - Standard horsepower and terminal dimensions are calculated assuming an incline of 18°. Reducing the incline angle will reduce the horsepower requirements. This can save money on fixed incline stackers and stationary conveyors. For variable incline stackers, the 18° should be assumed in the event the application changes.

Tons Per Hour - Standard TPH is calculated at a belt speed of 300 FPM and a troughing angle of 20°. 35° idlers are installed which provides additional capacity to absorb surges and minimize spillage.

Drive options - Model 153 stackers of 40 hp or more may use balanced head end drive or twin head end drives in lieu of the wrap drive found on the model 150. Please consult the factory for questions regarding these applications.
The balanced drive places the motor opposite of the reducer, connecting them with a live shaft and flexible coupling. This requires additional structure and an additional bearing.
Twin drives use two smaller drives instead of one large drive, with one motor and reducer on each end of the head pulley shaft. While the HP of each motor is half that of a single large drive, the gear reducers required are frequently not those normally associated with that HP motor.

Gravity take-up - Generally, gravity take- up is required on conveyors of 150 feet or longer.

Electrical - Conveyors are normally furnished less wiring, starters, junction boxes, or plugs. If any of these items are requested, it is important that all necessary items are on site during erection of the conveyor. When wiring is specified to a junction box or plug, a junction box, plug or other connecting means are required for each electrical item on the conveyor.
Lengths of wire required:
drive motor -- full length of conveyor
electric radial travel -- 1/2 length of conveyor
hydraulic power unit -- 1/2 length of conveyor
E-stop -- 1/2 length of conveyor for each switch
Starters - Reversing starters are required on shuttle conveyors, reversing conveyors, and on power radial travel motors.

GENERAL INFORMATION
(continued)

Potential Pitfalls - continued

Roller bearings - If the conveyor is to have roller bearings, be sure to include a pair of roller bearings for <u>each and every shaft less than 3-15/16" dia</u>.
- head terminals 5 to 20 hp, one pair
- head terminals 25 to 40 hp, two pair
- gravity take-up, three pair

Special hoppers - Hoppers which handle very large material, require A/R (abrasion resistant) liners, have a unique configuration, or are otherwise required to be of heavier than normal material need to be considered.

Belt feeders - Conveyors which are used as feeders have unique requirements. Belt speeds are often slower than normal. The conveyor must start and stop repeatedly with a full belt, and often with a head of material. It is best to consult the factory for assistance on these conveyors.

COMPONENT ALIGNMENT AND OPERATION

Accurate alignment of all components is most important.

All Terminal assemblies should be square, level and in line.

All idlers should be perpendicular to line of belt travel, properly spaced and level.

Belt splice should be square to center line of belt.

All shafts should be free to turn by hand without belt in place.

All bolts, should be securely tightened.

ALIGNMENT AND INITIAL OPERATION

Before placing belt conveyor in operation, check the following:

Object on Belt - Carefully check for and remove any tools, bolts, nuts, etc. that might have been left on the belt after installation. This is especially important to the return side of the belt where objects may get between the terminal pulleys and belt, thus causing damage to belt.

Automatic Take-up - See that the pulley revolves freely and the take-up frame slides easily to compensate for variations in belt tension. Use recommended amount of counterweight and adjust if necessary.

Manual Take-up - Adjust so that the tension will permit the loaded belt to just travel over the terminal pulleys without slipping. Excessive take-up on the belt will cause undue strain on shafting, bearings, and belt splicing. It will also tend to keep the belt from troughing properly.

Belt Training - After the take-ups are properly adjusted and working freely, allow the conveyor to run without load for belt training, which is accomplished by shifting the idlers. **Never attempt to train belt by unequal adjustment of screw take-ups** as this will disturb the terminal pulley alignment.

Belts will usually fleet (continue to run to one side) toward the idler roll it first touches. To correct fleeting **align the return idler first**, starting with the fourth to sixth idler back (from head pulley) of the runout point and work toward the tail

GENERAL INFORMATION
(continued)

ALIGNMENT AND INITIAL OPERATION
(continued)

pulley. Line up idlers in direction of belt travel. It is better to adjust a number of idlers slightly than to adjust one or two a great deal.

With the return idlers positioned, the troughing idlers can be aligned in the same manner, remembering to start in back of and always work toward the runout point in the same direction of the belt travel.

INITIAL OPERATION AND BREAK-IN

Sequence of Operation - After belt has been properly trained while running empty, check to see that electric controls are properly wired to provide proper starting and stopping sequence.

Starting and Stopping - Material should not be discharged onto a conveyor that is not operating. Conversely, when stopping a belt conveyor or conveyor system, stop discharge of material onto initial receiving conveyor and then in succession, the remaining conveyors after each has run off its load.

Loading - Apply load gradually. Do not overload.

Chutes - Chutes should deliver material to belt centrally, without excessive impact, and in same direction of velocity of belt travel. Chutes should be kept clean and free of any material that may have formed into chunks. Inspect periodically for any trapped material between belt and chute.

Skirt Seals - Skirt seals should be checked occasionally to see that they are adjusted properly, and material has not become trapped between skirt and belt, thus causing abrasion to belt.

Belt Scrapers - The scrapers are located at the head end of the belt conveyors to remove material from belt and into the receiving chute instead of bypassing the chute and accumulating on the belt. A counterweight or spring keeps the scraper blade against the belt. Proper field adjustment is required periodically.

Belt Retraining - With the belt conveyor operating under normal load, check the belt for any runout. If necessary realign idlers as described in "Belt Training" above.

RECOMMENDATIONS FOR CORRECTING CONVEYOR BELT PROBLEMS

Problems	Cause	Correction
Belt "runs off" one side of head pulley or foot pulley	Pulley not square with axis of belt	Head Pulley: Adjust headshaft bearing by moving forward the end of shaft on the side the belt runs off the pulley. Foot Pulley: Adjust footshaft bearing by moving backward the end of shaft on the side the belt runs off the pulley.
	Pulley shaft is not level transversely	Make certain pulley shaft is level by the use of shims under bearings.
Belt runs to one side at one point on frame.	Idlers not square with frame just preceding trouble point Conveyor frame not aligned Frame out of level transversely Sticking idlers Build-up of material on idlers and return rolls Terminal pulley mis-aligned Spilled material forcing belt to one side.	Advance the end of one or two idlers on run-out side. Stretch string to check, then align frame. Check and level frame. Replace if necessary. Improve maintenance practices. Improved maintenance. Install cleaning devices. Check and adjust both terminals. Correct the cause of spillage.
Long segment or entire belt runs to one side	Structure out of line or not level transversely Belt not cut and laced square Bowed belt (new) Off center loading	Check and correct. Correct the cause. Operate under full load tension for "break-in" period. Avoid poor storage practice such as "telescoped" roll or one edge close to damp ground or wall. Correct the cause at loading point.
Excessive stretch	Tension too high	Increase belt speed at same capacity. Reduce tonnage at same speed. Decrease belt tension with snub pulley. Install drive pulley lagging. Check for stuck or worn out idlers, spilled material.
	Belt construction too light	Check tonnage capacity and belt tension against belt specifications. Replace with belt of adequate specifications.

RECOMMENDATIONS FOR CORRECTING CONVEYOR BELT PROBLEMS (continued)

Problems	Cause	Correction
Grooving, gouging, or stripping of top cover	Hopper or Skirt Board pressed against belt	Use pliable skirt board rubber (not old belt) and adjust properly.
	Gap between idlers at loading point allowing material to grind between belt and flashing	Adjust skirt seals for minimum clearance. Closer idler spacing at loading point.
	Skirtboard metal too close to belt	Adjust to proper clearance.
	Width between skirts too narrow	Wider spacing, taper opening in direction of belt travel.
	Belt deflects at loading point allowing material to jam between seals and belt	Shift idler or chute so loading is just ahead of idler.
	Jamming of material against belt at head pulley in full bin or chute. Piled too high.	Limit switches or more careful operation.
	Build-up on return rolls	Rubber disc return rolls or improved belt cle[illegible]ning devices.
Excessive top cover wear	Stuck return rolls	Repair or replace.
	Dirty return rolls	Install rubber disc returns.
	Belt dragging thru spilled material	Adopt provisions for cleaning -- better housekeeping.
	Poor loading conditions such as side loading	Improve chutes and hoppers.
	Low tensile rating cover	When replaced, use higher quality, possibly heavier cover.
	Excessive sag between idlers (Load shift causes abrasion)	Closer spacing of troughing idlers.
Severe wear on pulley side	Sticking idlers	Replace bad rolls. Improve maintenance.
	Spillage of material on return belt	Self-cleaning foot pulley. Return belt cover. Deep trough idlers. Plow ahead of tail pulley. Use lacing with Nylon seal Vulcanized splice. Increase belt speed or decrease load feed.
	Head pulley lagging bolts protrude	Tighten bolts. Replace worn lagging. Vulcanized lagging.
	Slippage on drive pulley	Increase take-up tension. Rubber lagging on drive pulley - use corrugated type if belt is wet or frosty. Snub pulley to increase drive pulley contact.
Cover cutting or slashing	Sharp material impact	Impact idlers. Re-design loading chute for better delivery to belt.
	Tramp iron	Use metal detector or magnetic head pulley
Short breaks in carcass	Loading impact of sharp lumps	Reduce loading impact. Use impact idlers.
	Material between belt and pulley	Install plow ahead of pulley. Use self-cleaning pulley. Use deflector over gravity take-up pulley.

RECOMMENDATIONS FOR CORRECTING CONVEYOR BELT PROBLEMS

(continued)

Problems	Cause	Correction
Breaks at belt edge	Belt edges "folding up" on structure at or near pulleys	Install limit switch safety device. Provide more clearance.
	Material jamming under hopper or skirtboards	Adjust for proper clearance and relief.
	Final idler too close to head pulley or too high.	Adjust final idler location or height.
	Sharp convex curve	Adjust to more gradual curve.
Belt edge wear	Belt running out of line and rubbing against structure	See corrections suggested for all types of belt mis-alignment.
Transver breaks near fasteners	Fastener plates too long for pulley size	Use correct lacing. Use larger pulleys.
Fastener failure	Poor installation	Follow instructions.
	Wrong type or size	Use proper fasteners.
	Pulleys too small	Larger pulleys. Vulcanized splices.
	Belt tension to high	Correct per previous recommendations.
	Heat	Shield against source.
	Joining two belts of different thickness	Recess fasteners in thicker belt.
Cover swells or spots	Spilled oil or grease	Better housekeeping.
	Over-lubrication of troughing idlers	Better maintenance methods.
	Oil in material	Remove source. Replace with Neoprene oil-resistant belt.
Excessive "cupping"	Belt over-tensioned	Reduce take-up tension or counterweight on gravity take-up. Check for drag from stuck idlers. Reduce loading rate or increase belt speed to reduce tension. Check belt specs for tension requirements.
	High tension from deep trough idlers and low elasticity in belt fabric	Use belting with moderate stretch characteristics. Consult quality belt manufacturer.
	Heavy top cover on thin ply belt	Consult quality belt manufacturer.
Hardening & Cracking	Heat	Use Neoprene hot material belt
Belt is erratic	Belt is too stiff to train	Check quality belt manufacturer.
	Twisting of frame on portables and stackers	Brace loading hoppers so load and loading stresses do not allow frame to twist out of line.

MATERIAL WEIGHTS AND MAXIMUM ANGLE OF CONVEYING

Material	Avg. Wgt. Lbs. Per Cu. Ft.	Maximum Angle of Conveying
Alum, Lumpy	50-60	18°
Alum, Pulverized	45-60	20°
Ashes, Dray	35-40	22°
Ashes, Wet	45-50	250
Barley	38	16°
Bauxite, Crushed, Dray	75-85	20°
Bentonite, Pulverized	50	20°
Borax, Powered	50-55	22°
Cement, Bulk, in Bins	100	
Cement, Bulk, Conveying	65	20°
Cement Clinker	80-95	18°
Charcoal	18-25	20°
Cinders, Coal	40-45	22°
Coal, Anthracite	52-60	16°
Coal, Bituminous	50	22°
Coke, Breeze	25-34	22°
Coke, Loose	23-32	20°
Coke, Refiners	35-42	20°
Concrete, Wet		
6" Slump	150	12°
2" Slump	150	30°
Copper Ore	120-150	20°
Coral, Crushed	40-45	20°
Corn, Shelled	45	16°
Cullet	80-120	20°
Dolomite, Crushed	90-100	22°
Earth, Common		
Loam, Dry	76	20°
Loam, Wet	102-112	20°

MATERIAL WEIGHTS AND MAXIMUM ANGLE OF CONVEYING
(continued)

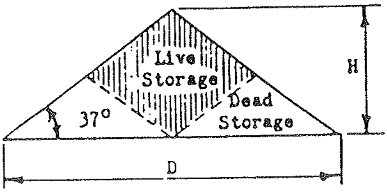
Material	Avg. Wgt. Lbs. Per Cu. Ft.	Maximum Angle of Conveying
Feldspar, Ground	65-70	18°
Flue Dust, Blast Furnace	110-125	18°
Fluospar	110	20°
Fullers Earth, Burnt	40	20°
Fullers Earth, Raw	35-40	20°
Glass, Broken or Cullet	80-120	20°
Granite, Crushed	95-100	20°
Gravel, Bank Run	100	20°
Gravel, Crusher Run	100	20°
Gravel, Sharp	90-100	20°
Gravel, Rounded	90-100	15°
Gypsum, Calcined	55-60	20°
Gypsum, Crushed	90-100	20°
Gypsum, Powered	60-80	23°
Iron Ore	120-180	22°
Kaolin Clay	63	20°
Lead Ore, Galena	465	22°
Lignite, Air Dried	45-55	20°
Lime, Ground	60	20°
Lime, Pebble	56	18°
Lime, Quick, Lumps	53	18°
Limestone, Agricultural	70	20°
Limestone, Crushed	85-90	20°
Limestone, Pulverized	75-85	20°
Limestone, Screenings	85-90	20°
Magnesite, Screened	120	20°
Magnesium Sulfate	70	18°
Magnesium Oxide	120	20°
Manganese Ore	120	22°
Marble, Crushed	90-95	20°
Mica, Flake	32	20°
Mica, Powder	61	20°
Milk, Dried, Flake	36	20°
Phosphate Rock	75-85	20°
Phosphate Sand	90-100	18°
Pumice, Ground	42-45	18°

MATERIAL WEIGHTS AND MAXIMUM ANGLE OF CONVEYING

(continue)

Material	Avg. Wgt. Lbs. Per Cu. Ft.	Maximum Angle of Conveying
Salt, Coarse	40-45	20^o
Salt, Fine	70-80	22^o
Sand, Bank, Damp	110-120	22^o
Sand, Bank, Dry	90-110	15^o
Sand, Foundry, Prepared	90	24^o
Sand, Foundry, Shakeout	90	20^o
Sand, Silica, Dry	90-100	15^o
Sand, Saturated	110-130	15^o
Sandstone, Quarried	82	15^o
Shale, Crushed	85-90	20^o
Sinter	100-135	18^o
Slag, Furnace, Crushed	80-90	18^o
Slag, Furnace, Granulated	60-65	22^o
Slate, Crushed	80-90	20^o
Slate, Ground	80	20^o
Soapstone, Talc	165-170	20^o
Soda Ash, Light	20-35	20^o
Soda Ash, Heavy	55-65	20^o
Sodium Nitrate	70-80	20^o
Stone, Crushed	85-90	20^o
Stone, Screenings	85-90	18^o
Stone, Dust	75-85	20^o
Sugar Beet Pulp, Dry	12-15	20^o
Sugar Beet Pulp, Wet	24-25	22^o
Sugar Cane, Knifed	15-18	15^o
Sugar Cane, Unknifed	22-25	15^o
Sugar, Raw	55-65	20^o
Sugar, Refined	50-55	15^o
Sulphur, Crushed	50-60	20^o
Sulphur, Lumpy	80-85	20^o
Sulphur, Powered	50-60	22^o
Talc	50-60	20^o
Trap Rock, Crushed	105-110	20^o
Vermiculite Ore	80	20^o
Wheat	45-48	16^o
Wood Chips	15-32	25^o
Zinc Ore, Crushed	160	20^o
Zinc Oxide, Light	10-15	20^o
Zinc Oxide, Heavy	30-35	20^o

CONICAL STOCKPILE STORAGE CAPACITY



Based on 100 lbs. per cu. ft. material

Angle of Repose - 37°

Total Volume (Cu. Yds.) = .0683 H^3

Total Volume (Tons) = .0922 H^3

H (Feet)	D (Feet)	Total (Cu. Yds.)	Total (Tons)	Live (Cu. Yds.)	Live (Tons)
10	26'- 6"	68	92	17	23
12	31'-10"	118	159	30	40
14	37'- 2"	187	252	47	63
16	42'- 6"	280	378	70	95
18	47'- 9"	398	537	100	135
20	53'- 0"	546	737	137	185
22	58'- 5"	727	981	182	246
24	63'- 8"	944	1274	236	319
26	69'- 0"	1200	1620	300	405
28	74'- 4"	1499	2024	375	506
30	79'- 6"	1844	2489	462	623
32	85'- 0"	2238	3021	560	756
34	90'- 3"	2684	3623	672	907
36	95'- 6"	3187	4302	798	1077
38	100'-10"	3748	5060	938	1266
40	106'- 2"	4371	5901	1094	1477
42	111'- 6"	5060	6831	1267	1710
44	116'- 9"	5818	7854	1457	1967
46	122'- 0"	6648	8975	1665	2248
48	127'- 5"	7553	10197	1891	2553
50	132'- 8"	8538	11526	2138	2886
52	138'- 0"	9604	12965	2405	3247
54	143'- 4"	10755	14519	2693	3636
56	148'- 7"	11995	16193	3004	4055
58	153'-11"	13326	17990	3337	4505
60	159'- 0"	14753	19916	3694	4987
65	172'- 6"	18757	25321	4697	6341
70	185'- 8"	23427	31626	5866	7919
75	199'- 0"	58814	38898	7215	9740
80	212'- 4"	34970	47208	8755	11820
85	225'- 6"	41944	56625	10503	14179
90	238'-10"	49790	66217	12467	16830
95	252'- 2"	58559	79054	14663	19795
100	265'- 4"	68300	92205	17102	23088

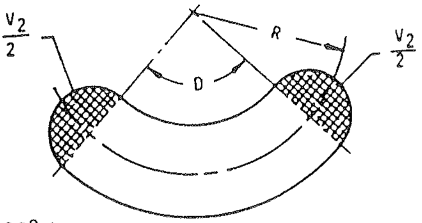
VOLUMES OF KIDNEY SHAPED STOCKPILES

To determine the total volume of a kidney shaped stockpile, utilize the following formula:

$V = (V_1 \times D) + V_2$
V = Volume in Yds. or Tons

V_1 = Volume in 1" of Arc
D = Degrees of Arc

V2 = Volume of Ends
(See Conical Stockpile Chart)



Example: 30 Ft. High Pile, 120 Ft. Radius 90° Arc
V = (92.62 x 90) + 1844 = 10,179.8 Yards
or
V = (125.04 x 90) + 2489 = 13,742.6 Tons

Radius In.		Cubic Yard & Tons per Degree of Arc (Less Ends) Stockpile Height in Feet (Meters)									
		10 (3)		15 (4.5)		20 (6)		25 (7.6)		30 (9)	
(Ft.)	(M)	Yds.	Tons	Yds.	Tons	Yds.	Tons	Yds.	Tons	Yds.	Tons
25	7.6	2.14	2.89								
30	9	2.57	3.47								
35	10.6	3.00	4.05	6.75	9.12						
40	12	3.43	4.63	7.72	10.42	13.72	18.52				
45	13.6	3.86	5.21	8.68	11.72	15.44	20.84				
50	15.2	4.29	5.79	9.65	13.02	17.15	23.16	26.80	36.18		
55	16.7	4.72	6.37	10.61	14.33	18.87	25.47	29.48	39.80		
60	18.2	5.15	6.95	11.58	15.63	20.58	27.79	32.16	43.42	46.31	62.52
65	19.7	5.57	7.53	12.54	16.93	22.30	30.10	34.84	47.03	50.17	67.73
70	21	6.00	8.10	13.51	18.23	24.01	32.42	37.52	50.65	54.02	72.94
75	22.8			14.47	19.54	25.73	34.73	40.20	54.27	57.89	78.15
80	24.3			15.44	20.84	27.44	37.05	42.88	57.89	61.75	83.36
85	25.8			16.40	22.14	29.16	39.36	45.56	61.51	65.61	88.57
90	27.3			17.37	23.44	30.87	41.67	48.24	65.12	69.46	93.77
95	28.8			18.33	24.74	32.58	43.99	50.92	68.74	73.72	98.98
100	30.4			19.29	26.04	34.30	46.31	53.60	72.36	77.18	104.19
105	31.9					36.01	48.62	56.28	75.97	81.04	109.41
110	33.4					37.73	50.94	58.96	79.59	84.90	114.62
115	34.9					39.45	53.25	61.64	83.28	88.76	119.83
120	36.4							64.32	86.83	92.62	125.04
125	38							67.00	90.45	96.48	130.25
130	39.5							69.68	94.07	100.34	135.46
135	41							72.36	97.69	104.20	140.67
140	42.5									108.06	145.88
145	44									111.92	151.09
150	45.6									115.78	156.30

VOLUMES OF KIDNEY SHAPED STOCKPILES
(continued)

Radius In.		Cubic Yard & Tons per Degree of Arc (Less Ends)							
		Stockpile Height in Feet (Meters)							
		35 (10.6)		40 (12)		45 (13.6)		50 (15.2)	
(Ft.)	(M)	Yds.	Tons	Yds.	Tons	Yds.	Tons	Yds.	Tons
25	7.6								
30	9								
35	10.6								
40	12								
45	13.6								
50	15.2								
55	16.7								
60	18.2								
65	19.7								
70	21								
75	22.8								
80	24.3								
85	25.8	89.30	120.55						
90	27.3	94.55	127.94	123.49	166.71				
95	28.8	99.80	134.73	130.35	175.98				
100	30.4	105.05	141.82	137.21	185.24				
105	31.9	110.31	148.92	144.08	194.51	182.35	246.17		
110	33.4	115.56	156.01	150.94	203.77	191.03	257.89		
115	34.9	120.82	163.10	157.80	213.03	199.72	269.62	246.56	332.86
120	36.4	126.07	170.19	164.66	222.29	208.04	281.34	257.28	337.33
125	38	131.32	177.28	171.52	231.55	217.08	293.06	286.00	361.80
130	39.5	136.57	184.37	178.38	240.82	225.77	304.78	278.72	376.28
135	41	141.83	191.47	185.24	250.08	234.45	316.51	289.44	390.75
140	42.5	147.08	198.56	192.01	259.34	243.13	328.23	300.16	405.22
145	44	152.33	205.65	198.97	268.60	251.82	339.95	310.88	419.69
150	45.6	157.59	212.74	205.83	277.86	260.50	351.67	321.60	434.16

CAPACITY CHARTS

The following conveyor belt capacity charts show tons per hour (TPH) and metric tons based on material weighing 100 lbs. per cubic foot, 20° material surcharge angle with three equal length rolls on troughing idlers. CAPACITY (TPH) = .03 x Belt Speed (FPM) x material weight (lb. per cu. ft.) x load cross section (Sq. ft.).

TPH WITH 20° TROUGHING IDLERS (METRIC TONS)														
Belt Width		Load Cross	Belt Speed in Feet Per Minute (Meters Per Minute)											
(In.)	(mm)	Section Sq. Ft.	100 (30)	150 (45)	200 (60)	250 (76)	300 (91)	350 (109)	400 (121)	450 (139)	500 (152)	550 (167)	600 (182)	650 (197)
18"	457	.180	54 (48)	80 (72)	110 (99)	135 (122)	160 (145)	190 (172)	218 (197)	243 (220)	270 (244)	-- --	-- --	-- --
24"	609	.333	100 (90)	150 (136)	200 (181)	250 (226)	300 (272)	350 (317)	400 (362)	450 (408)	500 (453)	550 (498)	600 (544)	-- --
30"	762	.533	160 (145)	240 (217)	320 (290)	400 (362)	480 (436)	560 (507)	640 (580)	720 (653)	800 (725)	880 (798)	960 (870)	1040 (943)
36"	914	.780	235 (213)	350 (317)	470 (426)	585 (530)	700 (634)	820 (743)	935 (848)	1050 (952)	1170 (1061)	1290 (1170)	1400 (1269)	1520 (1378)
42"	1066	1.100	330 (299)	495 (448)	660 (598)	825 (748)	980 (888)	1155 (1047)	1320 (1197)	1485 (1346)	1650 (1496)	1815 (1646)	1980 (1795)	2140 (1940)
48"	1219	1.467	440 (349)	660 (598)	880 (798)	1100 (997)	1320 (1197)	1540 (1396)	1760 (1596)	1980 (1795)	2200 (1995)	2420 (2194)	2640 (2394)	2860 (2594)
54"	1371	1.900	570 (516)	855 (775)	1140 (1033)	1420 (1287)	1710 (1550)	2000 (1814)	2280 (2067)	2560 (2321)	2850 (2584)	3130 (2838)	3420 (3101)	3700 (3355)
60"	1524	2.400	720 (653)	1080 (979)	1440 (1306)	1800 (1632)	2160 (1959)	2520 (2285)	2880 (2612)	3240 (2938)	3600 (3265)	3960 (3591)	4320 (3918)	4680 (4244)

Note: Capacities of flat belts are taken at one-half of those listed above.

CAPACITY CHARTS
(continued)

TPH WITH 35° TROUGHING IDLERS (METRIC TONS)														
Belt Width		Load Cross	Belt Speed in Feet Per Minute (Meters Per Minute)											
(In.)	(mm)	Section Sq. Ft.	100 (30)	150 (45)	200 (60)	250 (76)	300 (91)	350 (109)	400 (121)	450 (139)	500 (152)	550 (167)	600 (182)	650 (197)
18"	457	.225	66 (59)	100 (90)	135 (122)	170 (154)	200 (181)	235 (213)	270 (244)	305 (276)	338 (306)	--	--	--
24"	609	.416	125 (113)	187 (169)	250 (226)	310 (281)	380 (344)	435 (394)	500 (453)	560 (507)	625 (566)	685 (621)	750 (680)	--
30"	762	.666	200 (181)	300 (272)	400 (362)	500 (453)	600 (544)	700 (634)	800 (725)	900 (816)	1000 (907)	1100 (997)	1200 (1088)	1300 (1179)
36"	914	1.000	300 (272)	450 (408)	600 (544)	750 (680)	900 (816)	1050 (952)	1200 (1088)	1350 (1244)	1500 (1360)	1650 (1496)	1800 (1632)	1950 (1768)
42"	1066	1.410	420 (380)	635 (575)	845 (766)	1060 (961)	1270 (1151)	1480 (1342)	1690 (1532)	1900 (1723)	2120 (1922)	2320 (2140)	2540 (2303)	2750 (2494)
48"	1219	1.875	560 (507)	845 (766)	1125 (1020)	1400 (1269)	1690 (1532)	1970 (1786)	2250 (2040)	2530 (2284)	2810 (2548)	3090 (2802)	3370 (3056)	3660 (3319)
45"	1371	2.470	740 (671)	1110 (1006)	1480 (1342)	1850 (1677)	2220 (2013)	2600 (2358)	2960 (2684)	3340 (3029)	3700 (3355)	4080 (3700)	4450 (4036)	4820 (4371)
60"	1524	3.120	935 (848)	1400 (1269)	1870 (1696)	2340 (2122)	2800 (2539)	3280 (2974)	3740 (3392)	4200 (3809)	4680 (4244)	5150 (4671)	5610 (5088)	6100 (5532)

CAPACITY CHARTS
(continued)

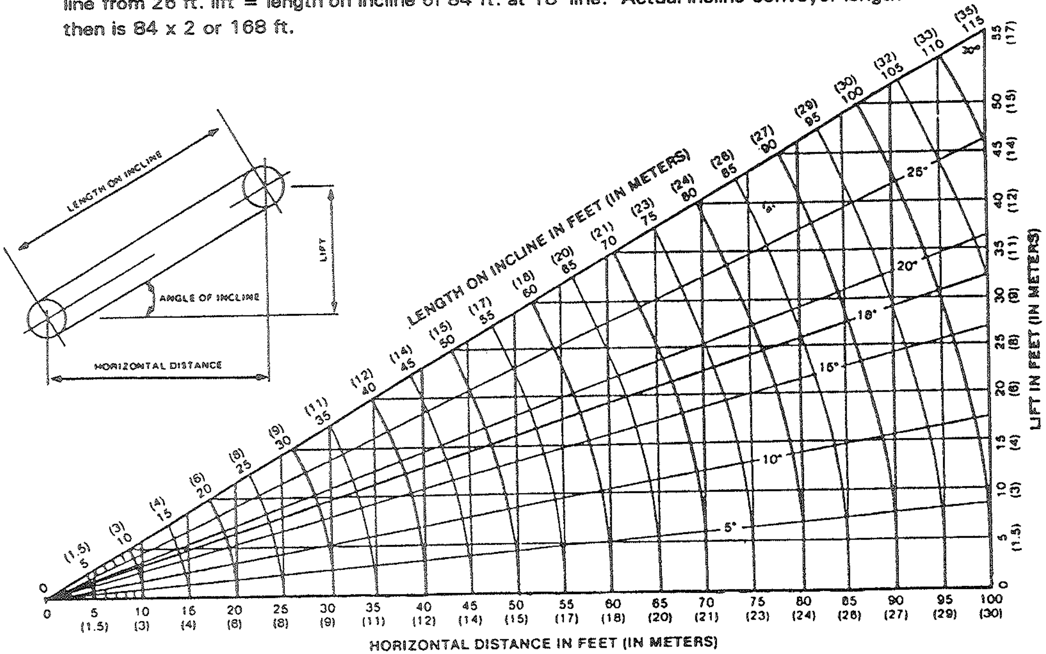
TPH WITH 45° TROUGHING IDLERS (METRIC TONS)														
Belt Width		Load Cross	Belt Speed in Feet Per Minute (Meters Per Minute)											
(In.)	(mm)	Section Sq. Ft.	100 (30)	150 (46)	200 (60)	250 (76)	300 (91)	350 (109)	400 (121)	450 (139)	500 (152)	550 (167)	600 (182)	650 (197)
24"	609	.483	145 (131)	217 (196)	290 (263)	360 (326)	435 (394)	508 (460)	580 (526)	650 (589)	725 (657)	795 (721)	870 (789)	-- --
30"	762	.733	232 (210)	348 (315)	465 (421)	580 (526)	695 (630)	810 (734)	930 (843)	1040 (943)	1160 (1062)	1270 (1151)	1390 (1260)	1500 (1360)
36"	914	1.130	335 (303)	510 (462)	680 (616)	850 (770)	1020 (925)	1190 (1079)	1360 (1233)	1530 (1387)	1700 (1541)	1860 (1687)	2040 (1850)	2200 (1995)
42"	1066	1.595	478 (433)	720 (653)	960 (870)	1200 (1088)	1440 (1306)	1680 (1523)	1910 (1732)	2150 (1950)	2390 (2167)	2630 (2385)	2870 (2603)	3110 (2820)
48"	1219	2.127	640 (580)	955 (866)	1275 (1156)	1400 (1451)	1910 (1732)	2230 (2022)	2550 (2312)	2870 (2603)	3190 (2893)	3500 (3174)	3820 (3464)	4150 (3764)
45"	1371	2.760	830 (752)	1240 (1124)	1655 (1501)	2070 (1877)	2480 (2249)	2900 (2630)	3310 (3002)	3720 (3374)	4140 (3759)	4550 (4126)	4960 (4498)	5380 (4879)
60"	1524	3.480	1040 (943)	1570 (1432)	2090 (1895)	2610 (2367)	3130 (2838)	3660 (3319)	4180 (3791)	4700 (4262)	5220 (4734)	5740 (5206)	6260 (5677)	6800 (6167)

Maximum Size of *Lumps-Inches				Maximum Belt Speeds - Feet Per Minute		
Belt Width (In.)	(mm)	Equal Size Lumps	Mixed with 90% Fines	Light Free Flowing Material As Grain, Pulverized Coal 50 Lb./Cu. Ft.	Average Material As Sand, Gravel, Stone, Coal, Fine Ore 100 Lb./Cu. Ft.	Abrasive Material As Coal, Screened Lump Coke 30 to 50 Lb./Cu. Ft.
18"	457	3	5	500	500	400
24"	609	5	8	600	600	450
30"	762	6	11	700	650	500
36"	914	8	15	800	650	500
42"	1066	10	18	800	650	500
48"	1219	12	21	800	650	500
54"	1371	14	24	800	650	500
60"	1524	16	28	800	650	500

* Based on 20° Troughing Idlers and 100 Lb. Per Cu. Ft. Material.

INCLINED CONVEYOR CHART

For dimensions greater than the limits of the chart, divide the given dimensions by a figure to bring length within the range of the chart. Multiply the result by the same figure to restore the proportions. Example: 160 ft. horizontal distance, 52 ft. lift. Dividing by 2 = 80 ft. and 26 ft. Intersection of vertical line from 80 ft. horizontal distance and horizontal line from 26 ft. lift = length on incline of 84 ft. at 18° line. Actual incline conveyor length then is 84 x 2 or 168 ft.



HORSEPOWER CHARTS

The horsepower required at the drive shaft of a conveyor is the sum of factors A, B and C as calculated from the charts below. Add 14% of this sum to determine the TOTAL MOTOR HORSEPOWER. The 14% compensates for drive losses.

Note: Factor C is not required for horizontal conveyors, and is negative for declined conveyors.

FACTOR A
(Horsepower Required at Drive Shaft to Drive Conveyor Empty for Each 100 F.P.M. Belt Speed)

Belt Width		Conveyor Centers (C-C) Feet (Meters)											HP for Ea. 10' (3M) Increment
(In.)	(mm)	25 (8)	50 (15)	75 (23)	100 (30)	150 (46)	200 (61)	250 (76)	300 (91)	350 (106)	400 (122)	450 (137)	
14"	355	.1	.2	.2	.3	.3	.3	.35	.4	.45	.5	.55	.010
16"	406	.1	.2	.2	.3	.3	.4	.45	.5	.55	.6	.65	.010
18"	457	.2	.3	.3	.3	.4	.4	.45	.5	.55	.6	.65	.012
24"	609	.3	.3	.35	.4	.5	.6	.68	.7	.78	.8	.9	.015
30"	762	.4	.5	.55	.6	.7	.8	.9	1.0	1.1	1.2	1.3	.021
36"	914	.5	.6	.7	.8	.9	1.0	1.2	1.3	1.4	1.5	1.7	.025
42"	1006	.7	.8	.83	.9	1.1	1.3	1.5	1.6	1.8	1.9	2.1	.031
48"	1219	.8	.9	1.0	1.1	1.3	1.5	1.7	1.8	2.0	2.2	2.4	.035
54"	1371	1.0	1.2	1.3	1.4	1.7	1.9	2.2	2.4	2.6	2.8	3.1	.050
60"	1524	1.2	1.4	1.6	1.7	2.0	2.3	2.6	2.8	3.1	3.4	3.7	.060

FACTOR A
(Horsepower Required at Drive Shaft to Drive Conveyor Empty for Each 100 F.P.M. Belt Speed)

Belt Width		Conveyor Centers (C-C) Feet (Meters)										HP for Ea. 10' (3M) Increment
(In.)	(mm)	500 (152)	550 (167)	600 (182)	650 (198)	700 (213)	750 (228)	800 (243)	850 (258)	900 (274)	1000 (304)	
14"	355	.6	.65	.7	.75	.8	.85	.9	.93	.97	1.0	.010
16"	406	.7	.75	.8	.83	.85	.88	.9	.95	1.0	1.1	.010
18"	457	.7	.8	.8	.95	1.0	1.05	1.1	1.15	1.2	1.3	.012
24"	609	1.0	1.08	1.1	1.2	1.3	1.38	1.4	1.5	1.6	1.7	.015
30"	762	1.4	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.5	.021
36"	914	1.8	1.9	2.0	2.1	2.2	2.4	2.5	2.7	2.8	3.0	.025
42"	1006	2.2	2.4	2.5	2.7	2.8	3.0	3.1	3.3	3.5	3.8	.031
48"	1219	2.6	2.8	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.4	.035
54"	1371	3.3	3.6	3.8	4.1	4.3	4.5	4.7	5.0	5.2	5.7	.050
60"	1524	4.0	4.3	4.5	4.8	5.1	5.4	5.7	6.0	6.3	6.8	.060

HORSEPOWER CHARTS
(continued)

FACTOR B
(Horsepower Required at Drive Shaft to Convey Material Horizontally, Any Belt Speed, Any Material.)

		Conveyor Centers (C-C) Feet (Meters)											HP for Ea. 10' (3M) Increment
TPH	Metric Tons	25 (8)	50 (15)	75 (23)	100 (30)	150 (46)	200 (61)	250 (76)	300 (91)	350 (106)	400 (122)	450 (137)	
50	45	.25	.3	.32	.35	.4	.45	.5	.6	.65	.7	.75	.010
100	90	.50	.6	.65	.7	.8	.9	1.0	1.1	1.2	1.3	1.5	.020
150	136	.75	.8	.9	1.0	1.2	1.3	1.5	1.7	1.9	2.0	2.2	.035
200	181	1.0	1.1	1.2	1.3	1.5	1.8	2.0	2.2	2.4	2.7	2.9	.045
250	226	1.3	1.4	1.6	1.7	1.9	2.3	2.5	2.7	3.0	3.4	3.7	.050
300	272	1.5	1.7	1.9	2.0	2.3	2.7	3.0	3.3	3.7	4.0	4.4	.070
350	317	1.7	2.0	2.2	2.4	2.7	3.1	3.6	3.9	4.3	4.7	5.1	.080
400	362	2.0	2.2	2.5	2.7	3.2	3.6	4.1	4.4	4.9	5.3	5.8	.090
450	408	2.3	2.5	2.8	3.0	3.5	4.0	4.6	5.0	5.6	6.0	6.5	.100
500	453	2.5	2.8	3.1	3.3	3.8	4.4	5.0	5.6	6.2	6.7	7.3	.110
550	498	2.8	3.1	3.4	3.7	4.2	4.9	5.5	6.2	6.8	7.4	8.0	.120
600	544	3.0	3.3	3.7	4.0	4.6	5.3	6.0	6.7	7.4	8.0	8.7	.134
700	634	3.5	3.9	4.3	4.7	5.4	6.2	7.0	7.8	8.6	9.3	10.2	.156
800	725	4.0	4.4	4.9	5.3	6.2	7.1	8.0	8.9	9.8	10.7	11.6	.180
900	816	4.5	5.0	5.5	6.0	6.9	8.0	9.0	10.0	11.0	12.0	13.0	.200
1000	907	5.1	5.6	6.2	6.7	7.7	8.9	10.0	11.1	12.3	13.3	14.5	.225
1200	1088	6.0	6.7	7.4	8.0	9.3	10.7	12.0	13.3	14.7	16.0	17.4	.270
1400	1269	7.0	7.8	8.6	9.3	10.8	12.4	14.0	15.6	17.1	18.7	20.4	.310
1600	1451	8.0	8.9	9.8	10.7	12.3	14.2	16.0	17.8	19.0	21.0	23.0	.350
1800	1632	9.0	10.0	11.0	12.0	13.9	16.0	18.0	20.0	22.0	24.0	26.0	.390
2000	1814	10.0	11.1	12.2	13.3	15.4	17.8	20.0	22.0	25.0	27.0	29.0	.410

FACTOR B
(Horsepower Required at Drive Shaft to Convey Material Horizontally, Any Belt Speed, Any Material.)

		Conveyor Centers (C-C) Feet (Meters)										HP for Ea. 10' (3M) Increment
TPH	Metric Tons	500 (152)	550 (167)	600 (182)	650 (198)	700 (213)	750 (228)	800 (243)	850 (258)	900 (274)	1000 (304)	
50	45	.8	.85	.9	.95	1.0	1.05	1.1	1.15	1.2	1.3	.010
100	90	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.7	.020
150	136	2.3	2.5	2.7	2.9	3.0	3.2	3.3	3.5	3.7	4.0	.035
200	181	3.1	3.3	3.6	3.8	4.0	4.2	4.4	4.7	4.9	5.3	.045
250	226	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.1	6.8	.050
300	272	4.7	5.0	5.3	5.7	6.0	6.3	6.6	6.9	7.3	8.0	.070
350	317	5.5	5.9	6.2	6.6	7.0	7.4	7.8	8.2	8.6	9.4	.080
400	362	6.2	6.7	7.1	7.6	8.0	8.5	8.9	9.4	9.9	10.7	.090
450	408	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	12.0	.100
500	453	7.8	8.4	8.9	9.5	10.0	10.6	11.1	11.7	12.2	13.3	.110
550	498	8.6	9.2	9.8	10.5	11.0	11.7	12.2	12.9	13.4	14.7	.120
600	544	9.3	10.0	10.7	11.4	12.0	12.7	13.3	14.0	14.7	16.0	.134
700	634	10.9	11.7	12.4	13.2	14.0	14.7	15.6	16.4	17.2	18.7	.156
800	725	12.4	13.4	14.2	15.2	16.0	17.0	17.8	18.6	19.6	21.0	.180
900	816	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	24.0	.200
1000	907	15.6	16.7	17.8	18.9	20.0	21.2	22.0	23.1	24.3	27.0	.225
1200	1088	18.7	19.9	21.0	23.0	24.0	26.0	27.0	29.0	30.0	32.0	.270
1400	1269	22.0	23.0	25.0	27.0	29.0	30.0	31.0	33.0	34.0	37.0	.310
1600	1451	25.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0	43.0	.350
1800	1632	28.0	30.0	32.0	34.0	36.0	38.0	40.0	42.0	44.0	48.0	.390
2000	1814	31.0	33.0	36.0	38.0	40.0	42.0	44.0	46.0	48.0	53.0	.410

HORSEPOWER CHARTS
(continued)

FACTOR C
(Horsepower Required at Drive Shaft to Lift or Lower Material. Any Belt Speed, Any Material.)

		Vertical Lift or Drop in Feet (Meters)											
TPH	Metric Tons	5 (1.5)	10 (3)	15 (4)	20 (6)	25 (8)	30 (9)	35 (11)	40 (12)	45 (14)	50 (15)	55 (17)	60 (18)
50	45	.3	.5	.8	1.0	1.3	1.5	1.8	2.0	2.3	2.5	2.8	3.0
100	90	.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.1	5.6	6.1
150	136	.8	1.5	2.3	3.0	3.8	4.5	5.3	6.1	6.9	7.6	8.4	9.1
200	181	1.0	2.0	3.0	4.0	5.1	6.1	7.1	8.1	9.1	10.1	11.1	12.1
250	226	1.3	2.5	3.8	5.1	6.3	7.6	8.9	10.1	11.4	12.6	13.9	15.2
300	272	1.5	3.0	4.5	6.1	7.6	9.1	10.6	12.1	13.7	15.2	16.7	18.2
350	317	1.8	3.5	5.3	7.1	8.8	10.6	12.3	14.1	15.9	17.7	19.0	21.0
400	362	2.0	4.0	6.1	8.1	10.1	12.1	14.1	16.2	18.0	20.0	22.0	24.0
450	408	2.3	4.5	6.8	9.1	11.4	13.6	15.9	18.2	21.0	23.0	25.0	27.0
500	453	2.5	5.1	7.6	10.1	12.6	15.2	18.0	20.0	23.0	25.0	28.0	30.0
550	498	2.8	5.6	8.3	11.1	13.9	16.7	19.0	22.0	25.0	28.0	30.0	33.0
600	544	3.0	6.1	9.1	12.1	15.2	18.2	21.0	24.0	27.0	30.0	33.0	36.0
700	634	3.5	7.1	10.6	14.1	17.7	21.0	25.0	28.0	32.0	35.0	39.0	42.0
800	725	4.0	8.1	12.1	16.2	20.0	24.0	28.0	32.0	36.0	40.0	44.0	48.0
900	816	4.5	9.1	13.6	18.2	23.0	27.0	31.0	36.0	40.0	45.0	50.0	55.0
1000	907	5.1	10.1	15.2	20.0	25.0	30.0	35.0	40.0	46.0	51.0	56.0	61.0
1200	1088	6.1	12.1	18.2	24.0	30.0	36.0	42.0	48.0	55.0	61.0	67.0	73.0
1400	1269	7.1	14.1	21.0	28.0	35.0	42.0	50.0	57.0	64.0	71.0	78.0	85.0
1600	1451	8.1	16.2	24.0	32.0	40.0	48.0	57.0	65.0	73.0	81.0	89.0	97.0
1800	1632	9.1	18.2	27.0	36.0	45.0	55.0	64.0	73.0	82.0	91.0	100.0	109.0
2000	1814	10.1	20.0	30.0	40.0	51.0	61.0	71.0	81.0	91.0	101.0	111.0	121.0

FACTOR C
(Horsepower Required at Drive Shaft to Lift or Lower Material. Any Belt Speed, Any Material.)

		Vertical Lift or Drop in Feet (Meters)										
TPH	Metric Tons	65 (20)	70 (21)	75 (23)	80 (24)	85 (26)	90 (27)	95 (29)	100 (30)	105 (32)	110 (33)	125 (38)
50	45	3.3	3.5	3.8	4.0	4.3	4.6	4.9	5.1	5.3	5.6	6.3
100	90	6.6	7.1	7.6	8.1	8.6	9.1	9.6	10.1	10.6	11.1	12.6
150	136	9.9	10.6	11.4	12.1	12.9	13.7	14.5	15.2	15.9	16.6	18.9
200	181	13.1	14.2	15.2	16.2	17.1	18.1	19.1	20.0	21.0	22.0	25.0
250	226	16.4	17.6	18.8	20.0	22.0	23.0	24.0	25.0	27.0	28.0	32.0
300	272	19.7	21.1	23.0	24.0	26.0	27.0	28.0	30.0	32.0	34.0	38.0
350	317	23.0	25.0	27.0	28.0	30.0	32.0	33.0	35.0	37.0	39.0	44.0
400	362	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0	42.0	44.0	51.0
450	408	29.0	32.0	34.0	36.0	38.0	41.0	43.0	45.0	47.0	49.0	57.0
500	453	33.0	35.0	38.0	40.0	43.0	46.0	48.0	51.0	54.0	57.0	63.0
550	498	36.0	39.0	41.0	44.0	47.0	50.0	53.0	56.0	59.0	62.0	69.0
600	544	39.0	42.0	45.0	48.0	51.0	55.0	58.0	61.0	64.0	67.0	76.0
700	634	46.0	50.0	54.0	57.0	61.0	64.0	68.0	71.0	74.0	77.0	88.0
800	725	53.0	57.0	61.0	65.0	69.0	73.0	77.0	81.0	85.0	89.0	101.0
900	816	60.0	64.0	69.0	73.0	78.0	82.0	87.0	91.0	95.0	100.0	114.0
1000	907	66.0	71.0	76.0	81.0	86.0	91.0	96.0	101.0	106.0	111.0	126.0
1200	1088	79.0	85.0	91.0	97.0	103.0	109.0	115.0	121.0	127.0	133.0	152.0
1400	1269	92.0	99.0	106.0	113.0	120.0	127.0	134.0	141.0	148.0	155.0	177.0
1600	1451	105.0	113.0	121.0	129.0	137.0	145.0	153.0	162.0	170.0	178.0	202.0
1800	1632	118.0	127.0	136.0	145.0	154.0	163.0	172.0	182.0	191.0	200.0	227.0
2000	1814	131.0	141.0	151.0	162.0	172.0	182.0	192.0	202.0	212.0	222.0	253.0

HORSEPOWER CHARTS
(continued)

Horsepower Calculation Example:

For example, if we have a M240 - 36" x 220' conveyor operating at 350 FPM and carrying 800 TPH with a vertical lift of 45 feet, we would calculate the horsepower as follows:

FACTOR A	3.5 x [1.0 + 2(.025)]	= 3.675
FACTOR B	7.1 + 2(.180)	= 7.460
FACTOR C		= 36.00
Subtotal		47.135
X		1.14
Total		53.734

Therefore, we would use a 60 HP Drive for this conveyor.

SPAN CHARTS

MAXIMUM SPAN LENGTH FOR 24" (609mm) DEEP TRUSS FRAME

Belt Width (In.)	Heavy Duty Truss 2-1/2" x 2-1/2" x 1/4"		Extra Heavy Duty 3" x 3" x 1/4"	
	Without Walkway	With Walkway	Without Walkway	With Walkway
18"	44′	39′	49′	44′
24"	43′	38′	48′	43′
30"	43′	38′	47′	42′
36"	41′	36′	46′	41′
42"	40′	35′	44′	39′
48"	38′	33′	42′	37′

MAXIMUM SPAN LENGTH FOR 33" (838mm) DEEP TRUSS FRAME

Belt Width (In.)	Heavy Duty Truss 3" x 3" x 1/4"		Extra Heavy Duty 4" x 4" x 5/16"	
	Without Walkway	With Walkway	Without Walkway	With Walkway
18"	57′	52′	73′	68′
24"	56′	51′	72′	67′
30"	55′	50′	70′	65′
36"	53′	48′	68′	63′
42"	51′	46′	65′	60′
48"	49′	44′	63′	58′

MAXIMUM SPAN LENGTH FOR 42" (1066mm) DEEP TRUSS FRAME

Belt Width (In.)	Heavy Duty Truss 3" x 3" x 1/4"		Extra Heavy Duty 4 x 4" x 5/16"	
	Without Walkway	With Walkway	Without Walkway	With Walkway
18"	63′	58′	81′	76′
24"	62′	57′	80′	75′
30"	61′	56′	78′	73′
36"	59′	54′	76′	71′
42"	56′	51′	73′	68′
48"	54′	49′	70′	65′
54"	50′	45′	65′	60′

NOTE: For installations with walkway on both sides, deduct 5′ from "with walkway" span dimensions.

MAXIMUM OVERHANG AT HEAD END

(Center Line of Head Snaft to First Support)

24" (609mm) Deep Truss Frame		33" (838mm) Deep Truss Frame		42" (1066mm) Deep Truss Frame	
HP Drive	Overhang	HP Drive	Overhang	HP Drive	Overhang
5-20	10′	5-20	12′	5-30	15′
25-30	8′	25-30	9	40-60	10′
40-60	5′	40-60	7′	75-100	8′

USEFUL CONVEYOR INFORMATION

To find belt speed when Drive (Head) Pulley dia. and Drive (Head) Shaft RPM are known calculate as follows:

S = .262 DN

Where:

S = Belt Speed in Feet per Minute
D = Dia. of Drive (Head) Pulley in Inches
N = RPM of Drive (Head) Shaft

To find Drive (Head) Shaft RPM when Drive (Head) Pulley dia. and belt speed are known calculate as follows:

$$N = \frac{S}{.262D}$$

Where:

N = RPM of Drive (Head) Shaft
S = Belt Speed in Feet per Minute
D = Dia. of Drive (Head) Pulley in Inches

To find Drive (Head) Shaft RPM when Output RPM of Power Source, V-belt Sheave Diameters and reducer speed reduction are known, calculate as follows:

$$N = \frac{r\,(P_1)}{R\,(P_2)}$$

Where:

N = RPM of Drive (Head) Shaft
r = Output RPM of Power Source
Such as: Electric Motor - 1750 RPM
Engine - 1800 RPM
P_1 = Pitch Dia. of Driver Sheave
P_2 = Pitch Dia. of Driven Sheave
R = Ratio of Speed Reducer Reduction

To find Drive (Head) Shaft RPM when Output RPM of Speed Reducer and Number of Teeth in Sprockets are known, calculate as follows:

$$N = \frac{(r)\,T_1}{T_2}$$

Where:

N = RPM of Drive (Head) Shaft
r = Output RPM of Speed Reducer
T_1 = No. of Teeth in Driver Sprocket
T_2 = No. of Teeth in Driven Sprocket

HP Formula for Rubber Skirting

Formula for figuring extra HP to be added due to friction of rubber skirting on hoppers and extensions and skirt plates.

HP = .00018 x length of hopper or skirt in feet x belt speed (FPM).

The HP obtained should be added to HP to drive loaded conveyor.

CONVEYOR BELTING

We use only top quality rubber conveyor belting on our entire line of portable and stationary belt conveyors and feeders. Our belting is supplied by leading U.S. manufacturers of conveyor belting. Specifications can be varied to suit your requirement. Our belt standards are:

DESCRIPTION: 2 ply #150, 2 ply #220 and 3 ply #330
(Number designates tensile strength per inch of belt width)

COVERS: 1/8" top cover and 1/32" pulley cover and 3/16" x 1/16"
(Tensile strength 2500 to 3000 lbs/sq. in.)

TO CALCULATE BELT STRENGTH REQUIRED:

Formula:

$$T = \frac{HP \times 33000 \times K}{S}$$

T = Total belt tension in pounds
HP = Horsepower at drive shaft
S = Belt speed (feet per minute)
K = Factor from table below

Drive Pulley Degree of Wrap	"K" for Screw Take-Up		"K" for Counterweight Take-Up	
	Plain or Bare Drive Pulley	Lagged Drive Pulley	Plain or Bare Drive Pulley	Lagged Drive Pulley
180°	2.00	1.84	1.64	1.50
210°	1.80	1.67	1.50	1.38
220°	1.74	1.64	1.46	1.35
240°	1.66	1.54	1.40	1.30

EXAMPLE: 30" belt at 300 FPM, 37 HP at drive shaft, vertical gravity take-up, rubber lagged drive pulley with snub pulley giving 210 wrap on drive pulley.

$$T = \frac{37 \times 33000 \times 1.38}{300} = 5616 \text{ lbs tension at drive pulley}$$

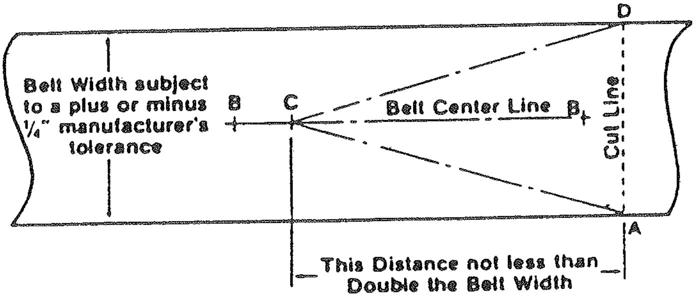
30" (belt width) x 220 lbs/in = 6600 lbs belt tension capacity

30" 2 ply #220 is proper for this application

NOTE: Increasing belt speed reduces total tension -- decreasing belt speed increases total tensions.

CONVEYOR BELTING
(continued)

HOW TO MARK AND CUT BELT SQUARE



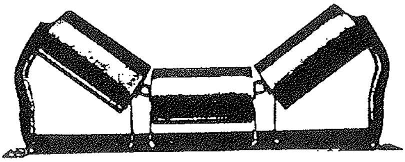
1. Locate point A at edge of belt where cut is desired.
2. Locate points B-B by measuring equal distance from belt edges to find true belt centerline.
3. Locate point C on the centerline at a distance from point A equal to double the belt width.
4. Locate point D on the opposite belt edge so that line CD equals line CA.
5. Draw a line between points D and A and cut the belt carefully along this line.

The cut will be square with the centerline of the belt, as it should be to run true.

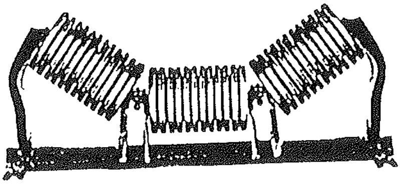
Use the same procedure at the other end of the belt and you have eliminated one cause of belt alignment problems.

TYPES OF IDLERS

Carrying Idlers (Troughing or Flat)
Support the belt in the section of the conveyor that transports the material. These may be flat, or 20°, 35°, and 45° troughing types of equal or unequal roll length. (Unequal rolls are used where magnetic separation, picking, etc., is required.)

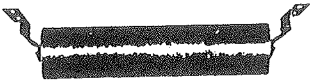


Impact Idlers
Prevent damage to the belt at the loading point. These idlers may be troughing or flat types with grooved, molded rubber rolls. It is standard practice to use impact idlers at all loading and transfer points when the impact force exceeds 40 foot pounds.



Return Idlers
Support the empty belt between the discharge point and the tail pulley.

a. **Standard** - Used where materials are not sticky, corrosive and abrasive.

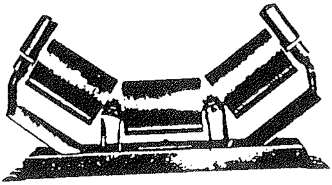


b. **Spiral** - Used where sticky materials adhere to the belt, where a corrosive environment is present or abrasive wear is a problem. Their unique construction minimizes belt fleet and damage to the return belt due to material buildup on the idler rolls. Spiral roll idlers can be used for belt travel in one direction only.

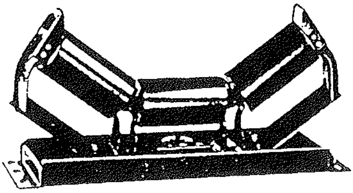
c. **Disc return** - Used under the same conditions as the spiral idler. These idlers can be used for belt travel in either direction. Massed end discs are standard.

TYPES OF IDLERS
(continued)

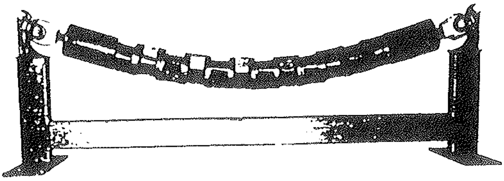
Carrying Belt Training Idlers (Troughing or Flat)
Assist in keeping the belt centered on the conveyor. Actuating shoe type is used on belt traveling in either direction. Positive type is used on belt traveling in one direction only and is illustrated.



Return Belt Training Idlers
Used for the same purposes as are Carrying Training Idlers. They are of the actuating shoe type, belt travel -- either direction, and the positive and inclined pivot types, belt travel - one direction only. The actuating shoe type is illustrated.



Catenary Idlers
The catenary idler is designed to handle wet, sticky or hot materials. Rubber rolls and steel cable in the roll element resist material buildup through continuous flexing action. Overall flexibility of the roll assembly provides smooth handling of lumpy materials. The roll is suspended from a mounting hook and swivel assembly.



TYPES OF IDLERS
(continued)

The following idler interchange table was provided as a courtesy by Rexnord. Interchangeability is based on (a) Backing Distance - from the bottom of the base pad to the top of the center roll of troughing idlers, and (b) Bolt Hole Spacing - across the width of the conveyor frame for troughing and return idlers. (Belt width plus 9").

Manufacturer	**CEMA B**	**CEMA C**	**CEMA D**	**CEMA E**
Rexnord	Series B	Series C	Series D	Series E
Continental Conveyor	B Plus	H	H Plus	SDX
Goodman Conveyor	B	C	D	E
Hewitt-Robins	B	2000	3000	4000
Link Belt	B2000	C3000	D3000	E4000
Precismeca	PB	PC	PD	PE
Precision Idler	B	C	--	--
Stephens-Adamson	2174-2175	4205-4206	5195-5196	6326-6327
Superior Machinery	60/61/71	80/81	--	--

RECOMMENDED AVERAGE SPACING OF IDLERS IN FEET

Belt Width		Carrying Idlers						Return Idlers
		Weight of Material Conveyed - Pounds Per Cubic Foot						
(mm)	(In.)	30	50	75	100	150	200	
457	18	5-1/2	5	5	5	4-1/2	4-1/2	10
609	24	5	4-1/2	4-1/2	4	4	4	10
762	30	5	4-1/2	4-1/2	4	4	4	10
914	36	5	4-1/2	4	4	3-1/2	3-1/2	10
1067	42	4-1/2	4-1/2	4	3-1/2	3	3	10
1219	48	4-1/2	4	4	3-1/2	3	3	10
1372	54	4-1/2	4	3-1/2	3-1/2	3	3	10
1524	60	4	4	3-1/2	3	3	3	10
1829	72	4	3-1/2	3-1/2	3	2-1/2	2-1/2	8
2137	84	3-1/2	3-1/2	3	2-1/2	2-1/2	2	8
2438	96	3-1/2	3-1/2	3	2-1/2	2	2	8

SPACING OF IDLERS

Normal Spacing (Carrying and Return Idlers) See Table 10 for recommendations.

Loading Point (Impact Idlers) - Normally, one-half the carrying idler spacing is recommended. For fine materials, place the idlers as close together as possible.

Convex Curves - One-half of normal spacing unless radius is small, then space closer.

Belt Training Idlers - The use of one training return idler approximately 12 to 15 belt widths before the tail or take-up pulley is recommended. Also place training idlers at approximately 100 foot intervals on the carrying and return runs.

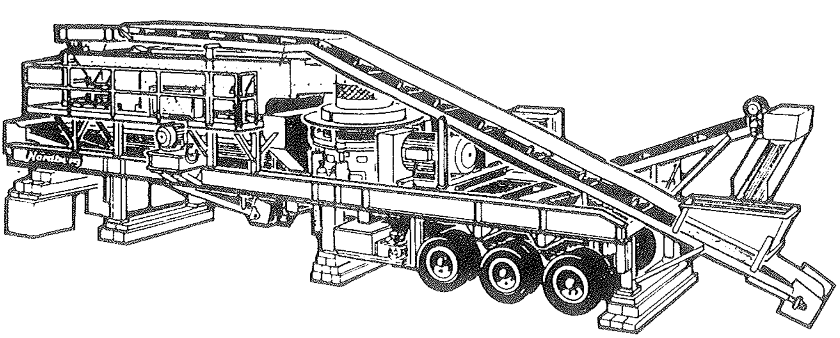
Spiral or Rubber Disc Return Idlers - Use two or three behind the head pulley. For very severe service, equip the entire run with these idlers.

Side Guide Idlers - Use only to insure against serious belt damage that may be caused by the belt running against the conveyor support structure. Place near the possible obstruction. They are not a corrective device.

Nordberg®

A Nordberg Group Company

Portable Plants



NORDBERG PORTABLE PLANTS

Nordberg offers a complete line of Portable Plants. The line includes Symons, Gyradisc, Omnicone, HP Series, C Series Jaw, Vertical Shaft Impactor, Horizontal Shaft Impactors and Screen Plants.

Symons Cone Plants:
Models include cone, cone/screen and close circuit plants. Cone only plants are available with 3', 4', 4-1/4' and 5-1/2' Symons Standard and Short Head Crushers. Cone/screen plants are available with 3', 4' and 4-1/4' Symons Standard and Short Head Crushers. The 3' Symons Standard and Short Head Crushers are the only model available in a close circuit plant.

Gyradisc Crusher Plants:
Models include cone only plants. These plants are available with 36", 48" and 66" Gyradisc Crushers.

Omincone Plants:
Models include cone, cone/screen and close circuit plants. Cone only plants are available with 1144, 1352 and 1560 Omnicones (Standard and Short Head Models are obtained by changing the crusher liners). Cone/screen plants are available with 1144 and 1352 Omnicones. The 1144 Omnicone is also available in a close circuit plant.

HP Series Plants:
Models include cone, cone/screen and close circuit plants. Cone only plants are available with HP200, HP300 and HP500 Crushers (Standard and Short Head Models are obtained by changing the crusher liners). Cone/screen plants are available with HP200 and HP300 Crushers. The HP200 and HP300 Crushers are also available in a close circuit plant.

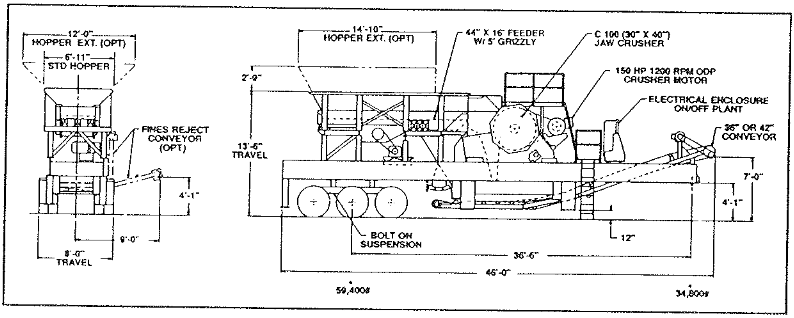
C Series Jaw Plants:
Models include jaw feeder plants with various options such as extended discharge conveyor, diesel power, hydraulic raising and leveling, variable speed feeder drives, hopper extensions, etc. Jaw plants are available with the C100 (30 x 40), C125 (37 x 49) and C140 (41 x 55) size crushers.

Vertical Shaft Impactor Plants:
Models include impactor only plants. These plants are available with either a 1680VI or a 2080VI Impactor.

Horizontal Shaft Impactor Plants:
Models include impactor, impactor/feeder, impactor/screen and recycle plants. Impactor only plants are available with the HS1310, HSR1315 and HS1415 Impactors. Impactor/Feeder plants are available with the HS1310, HSR1315 and HS1415 Impactors. The impactor/screen plants are available in either open circuit or close circuit configurations. The open circuit plant plants are available with the HS1310, and HSR1315. Recycle plants are available with the HSR1315 and HS1415 models. These recycle plants can be used with either concrete or asphalt or both types of materials.

Screen Plants:
Models include both dry and wet screen plants. Screen plants are available with 5'x14', 5'x16', 6'x16', 6'x20' and 8'x20 double deck and triple deck models.

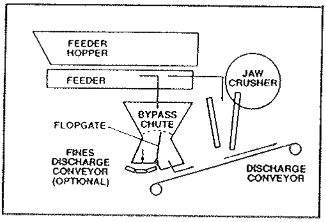
NORDBERG PC100 VF PORTABLE JAW PLANT GENERAL ARRANGEMENT



Dimensions	FEEDER SIZE: 16' (STD)	20' (OPT)
Approx. Total Weight	94,200#	102,000#
Approx. Rear Axle Weight	59,400#	63,000#
Travel Height	13'-6"	14'-0"
Travel Width	8'-0"	8'-0"
Overall Length	46'	47'
Hopper Capacity – Std.	8 yd³	10 yd³
– w/Ext.	14 yd³	18 yd³

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Material Flow Diagram



C-Series Jaw Crusher Capacities

Closed Side Setting	CRUSHER SIZE					
	C80B		C100B		C125B	
Inch (mm)	STPH	MTPH	STPH	MTPH	STPH	MTPH
1-1/2 (38)	60-75	54-68				
2 (51)	70-85	64-77	95-110	86-100		
2-1/2 (64)	90-110	82-100	110-140	100-127		
3 (76)	105-125	95-113	120-160	109-145	200-235	181-213
3-1/2 (89)	110-135	100-122	140-180	127-163	210-250	190-227
4 (102)	120-150	109-136	175-220	159-200	220-275	200-249
4-1/2 (114)	130-170	118-154	190-245	172-222	240-295	218-268
5 (127)			225-280	204-254	270-345	245-313
6 (152)			255-325	231-295	340-400	308-363
7 (178)					385-480	349-435
8 (203)					450-545	408-494

For more information contact:

Nordberg Inc.
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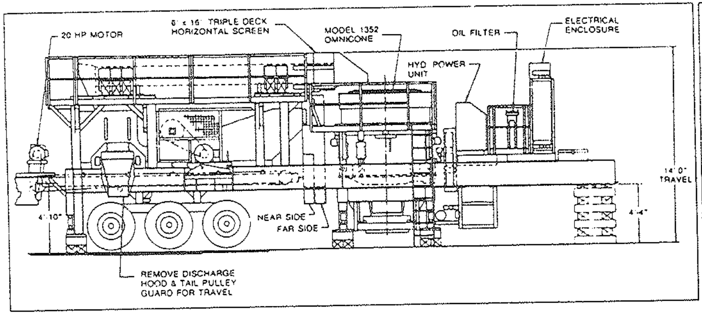
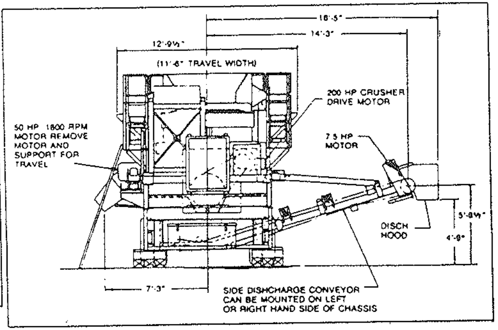
NORDBERG P5202 PORTABLE CONE/SCREEN PLANT GENERAL ARRANGEMENT

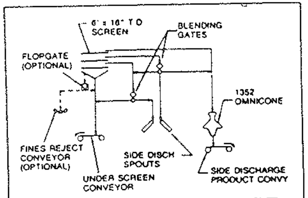




SPECIFICATIONS

Approx. Total Weight 104,000#
Approx. Rear Axle Weight 68,000#
Operating Height 14'-3"
Travel Height 14'-0"
Travel Width 11'-6"
Overall Length 43'-3"

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE



MATERIAL FLOW CHART

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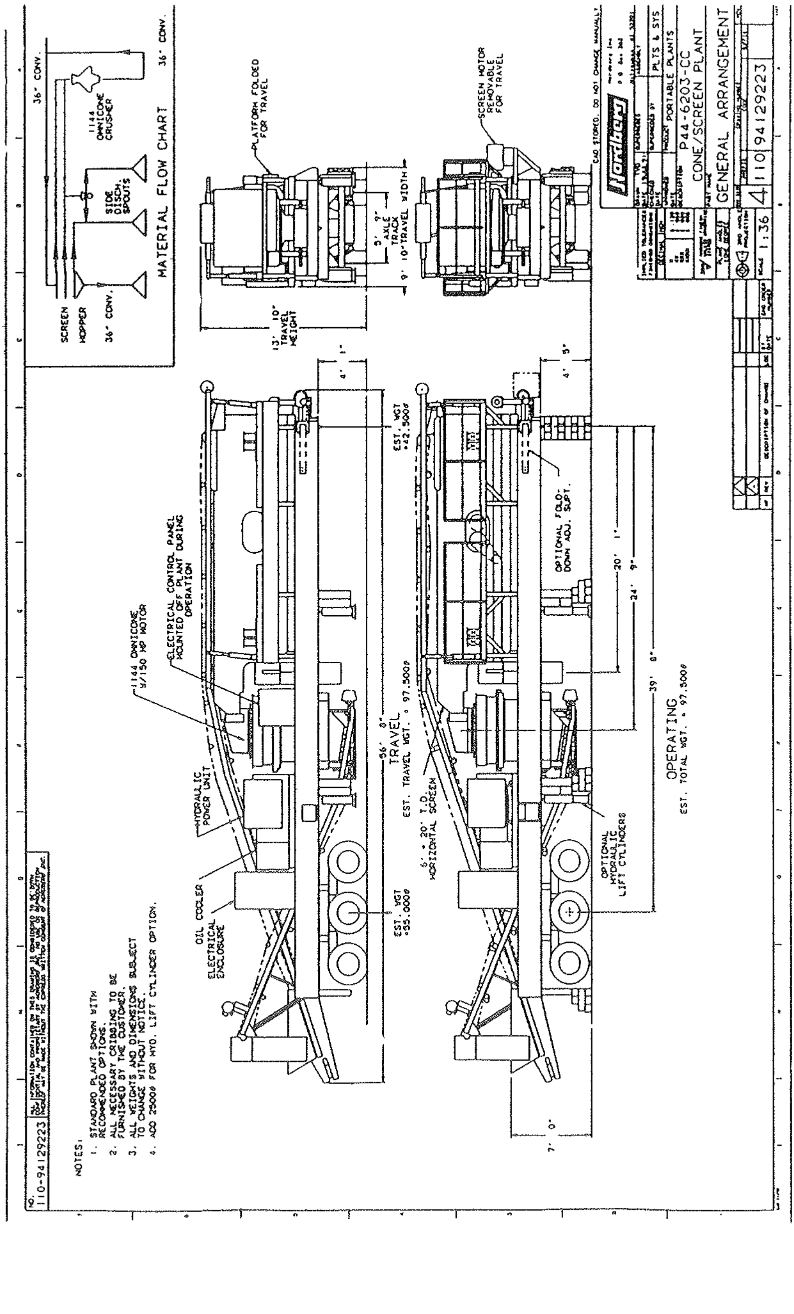
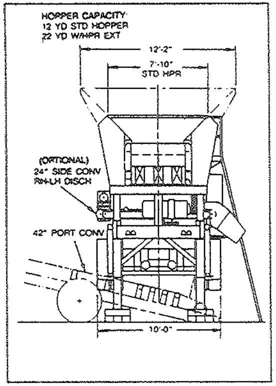
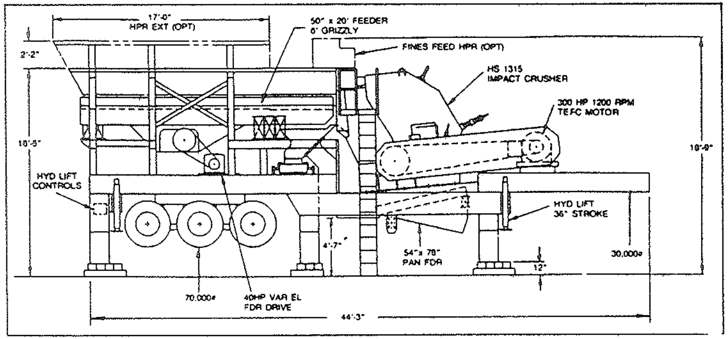

MATERIAL FLOW CHART
SCREEN
HOPPER
36" CONV.
SIDE DISCH. SPOUTS
1144 OMNICONE CRUSHER
PLATFORM FOLDED FOR TRAVEL
SCREEN MOTOR REMOVABLE FOR TRAVEL
13' 10" TRAVEL HEIGHT
5' 9" AXLE TRACK
9' 10" TRAVEL WIDTH
ELECTRICAL CONTROL PANEL MOUNTED OFF PLANT DURING OPERATION
1144 OMNICONE W/150 HP MOTOR
HYDRAULIC POWER UNIT
OIL COOLER
ELECTRICAL ENCLOSURE
56' 8"
TRAVEL
EST. TRAVEL WGT. = 97,500#
6' x 20' T.D. HORIZONTAL SCREEN
OPTIONAL FOLD-DOWN ADJ. SUPT.
OPTIONAL HYDRAULIC LIFT CYLINDERS
OPERATING
EST. TOTAL WGT. = 97,500#
NOTES:
1. STANDARD PLANT SHOWN WITH RECOMMENDED OPTIONS.
2. ALL NECESSARY CRIBBING TO BE FURNISHED BY THE CUSTOMER.
3. ALL WEIGHTS AND DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.
4. ADD 2500# FOR HYD. LIFT CYLINDER OPTION.
110-94129223
PORTABLE PLANTS
P44-6203-CC
CONE/SCREEN PLANT
GENERAL ARRANGEMENT
110 94129223
1:36

NORDBERG P1315VFR IMPACT CRUSHING PLANT GENERAL ARRANGEMENT





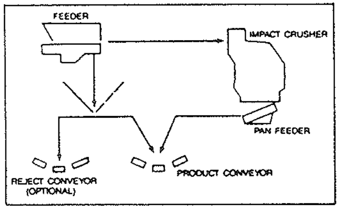
SPECIFICATIONS

Approx. Total Weight 100,000#
Approx. Rear Axle Weight 70,000#
Operating Height 16'5" (Standard Hopper)
Travel Height 14'0"*
Travel Width 10'0"
Overall Length 44'3"

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

*REQUIRES REMOVAL OF FINES FEED HOPPER AND OPTIONAL HOPPER EXTENSION.

PLANT FLOW DIAGRAM



For more information contact:
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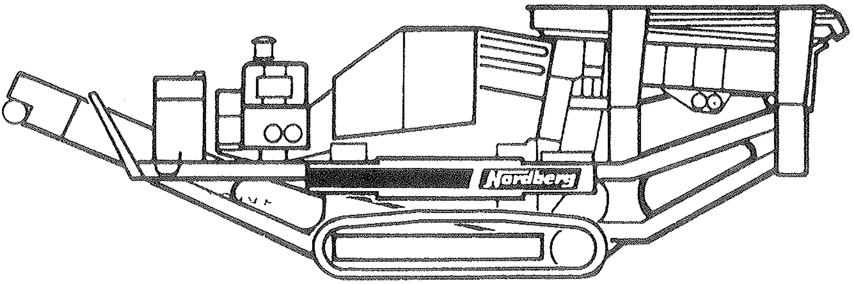
LOKOTRACK 12-6

Lokotrack Mobile Plants



NORDBERG LOKOTRACK

The Nordberg Lokotrack was originally developed for contractors who required a more economic tool for bidding jobs--where frequent moves or difficult terrain are encountered. Lokotrack is a valuable tool in that type of application, whether for conventional or recycle crushing.

Lokotrack is designed to provide a highly versatile, compact, portable, track-mounted crushing plant. These characteristics allow quarry and mining operators to crush right at the face.

Lokotrack must be considered as part of a Face Crushing System (FCS) when operating in the quarry. The method of feeding and removing material from the system is just as important as the Lokotrack itself.

The many options available on a Lokotrack make it a flexible tool which can be used in a variety of applications. These options include hoppers of different capacities, hydraulic breakers, control cabs, fines discharge conveyors, radio or infra-red remote control, and many others.

The versatility of a track-mounted crusher places few limitations on how it can be applied---as long as it is cost justified, and you remember to treat it in terms of a system concept.

QUARRY AND MINING APPLICATIONS

Haulage of blasted material is normally the largest single cost component in the production of primary crushed rock. It also represents the greatest opportunity for cost reduction. Crushing at the face can provide major benefits:

- Substantial reduction in the cost of truck haulage, or load and carry operations;

- Significant reduction of noise and dust pollution in the pit environment;

- Reductions in diesel emissions.

The ability of the Lokotrack to move to a new crushing location within minutes is of little use if the other system components, used with the Lokotrack, hinder that effectiveness. Choosing a front-end loader, hydraulic excavator, face shovel, portable conveyors, or shiftable conveyors all affect the efficiency of a Lokotrack and must be considered.

LOKOTRACK CAPACITIES (TPH) FOR BLASTED ROCK OF AVERAGE HARDNESS

Unit	Capacity
LT100	200-400
LT1415	200-400
LT125	400-700
LT140	700-1000

LOKOTRACK - SPECIAL APPLICATIONS

Quarry operators who must frequently move to different sites, or contractors who work in difficult areas, may require a Lokotrack that is not dependent upon cranes for disassembly and transport. The "S" series of Lokotrack fits that requirement.

The LT100S, LT125S, and the LT140S, are shorter versions that do not have a feeder. Blasted material is dumped by a hydraulic excavator directly into the feed hopper, covering the jaw crusher opening which can be hydraulically tilted to dump oversized boulders.

The heavier LT125S and LT140S models are easily dismounted into two pieces with the aid of hydraulic legs. The weight and dimensions of the units allow transportation on readily available trailers. No cranes are needed for disassembly or assembly.

"S" Series Capacities

Unit	Capacity
LT100S	100-250
LT125S	300-500
LT140S	500-650

"TRACK FACTS"

LOKOTRACK SPECIFICATIONS

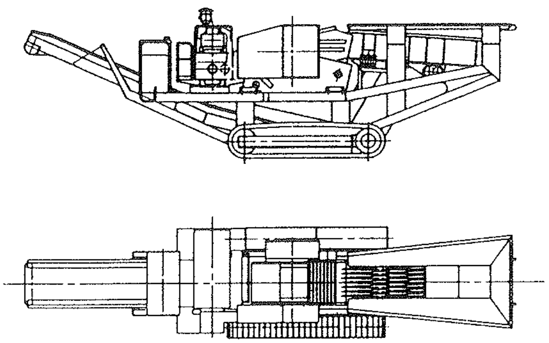
	LT100*	LT125*	LT140*
Jaw Crusher Size	30"x40"	37"x49"	41"x55"
Plant Weight (Tons)	52	92	124
Transport Width	10'-0"	11'-6"	11'-6"
Transport Height	12'-6"	12'-6"	12'-0"
Transport Loads	1	3	4

*Available in recycle configurations.
The above mentioned capacities are for blasted rock of average hardness.
Basic unit ready for mounting on a transport vehicle(s).

FEEDER HOPPER CAPACITIES

	Basic Hopper	Extended Hopper
LT100	6 yd	16 yd
LT125	6 yd	16 yd
LT140	16 yd	23 yd

NORDBERG LOKOTRACK 100 PORTABLE JAW PLANT GENERAL ARRANGEMENT



Dimensions	During transport/operation
Length	45'6" (13900 mm)
Width	10' (3000 mm)
Height	12'6" (3800 mm)
Weight	52 tons (47000 kg)

Unit machines

Crusher	NORDBERG C 100B jaw crusher —feed opening 30"/w x 40"/l (750 mm/w x 1000 mm/l) —setting range 2 3/4" to 8" (70 to 200 mm)
Feeder	B10-42-2V horizontal feeder - Grizzly

Engine and power transmission

Engine	155 kW/1900 rpm

The crusher is belt driven. The feeder, the belt conveyor and the tracks have hydraulic drive.

Tracks

Type	D6B

For more information contact:
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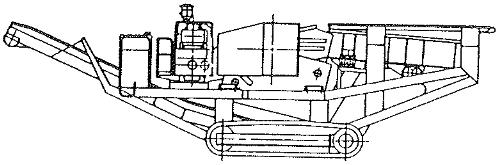
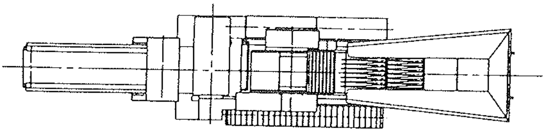
NORDBERG LOKOTRACK 100 R PORTABLE JAW PLANT
GENERAL ARRANGEMENT





Dimensions — During transport/operation

Length	47'6" (14500 mm)
Width	10' (3000 mm)
Height	12'6" (3800 mm)
Weight	54 tons (48500 kg)

Unit machines

Crusher	NORDBERG C 100 B jaw crusher – feed opening 30"/w × 40"/l (750 mm/w × 1000 mm/l) – setting range 2 3/4" to 8" (70 to 200 mm)
Feeder	B 10-42-2V horizontal feeder – Grizzly

Engine and power transmission

Engine 155 kW/1900 rpm

The crusher is belt driven. The feeder, the belt conveyor and the tracks have hydraulic drive.

Tracks

Type D6B

For more information contact:
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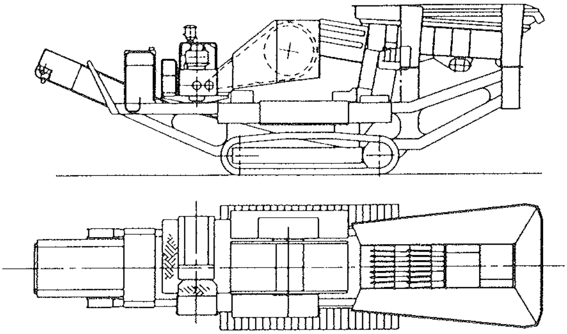
NORDBERG LOKOTRACK 125 PORTABLE JAW PLANT GENERAL ARRANGEMENT



Dimensions	During transport	During operation
Length	45' (13800 mm)	48' (14500 mm)
Width	11'6" (3500 mm)	11'6" (3500 mm)
Height	12'6" (3800 mm)	16' (4800 mm)
Weight support	48 tons (43000 kg)	total 92 tons (83000 kg)
Weight jaw crusher	44 tons (40000 kg)	

Unit machines

Crusher	NORDBERG C 125B jaw crusher —feed opening 37"/w x 49"/l (950 mm/w x 1250 mm/l) —setting range 4" to 10" (100 to 250 mm)
Feeder	B13-44-2V horizontal feeder - Grizzly

Engine and power transmission

Engine	245 kW/1900 rpm

The crusher is belt driven. The feeder, the belt conveyor and the tracks have hydraulic drive.

Tracks

Type	D7E

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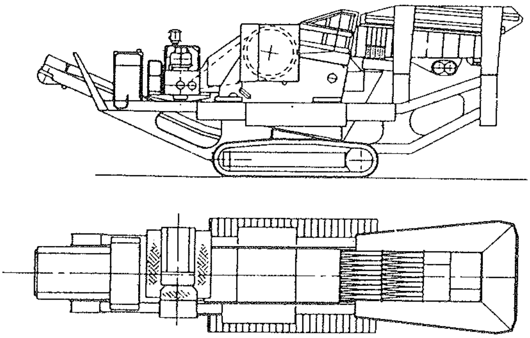
LOKOTRACK 140 GENERAL ARRANGEMENT



Dimensions	During transport	During operation
Length	52'6" (16000 mm)	54' (16500 mm)
Width	11'6" (3500 mm)	12'6" (3800 mm)
Height	12' (3600 mm)	19' (5800 mm)
Weight		124 tons (112000 kg)
Weight jaw crusher	55 tons (50000 kg)	
Weight support frame	26 tons (24000 kg)	
Weight tracks	2 x 12 tons (2 x 11000 kg)	
Weight feeder/hopper	18 tons (16000 kg)	

Unit machines

Crusher	NORDBERG C 140B jaw crusher —feed opening 42"/w x 55"/l (1050 mm/w x 1400mm/l) —setting range 5" to 10" (130 mm to 270mm)
Feeder	B16-50-3V horizontal Feeder - Grizzly

Engine and power transmission

Engine 245 kW/1900 rpm

The crusher is belt driven. The feeder, the belt conveyor and the tracks have hydraulic drive.

Tracks

Type D8H

For more information contact:
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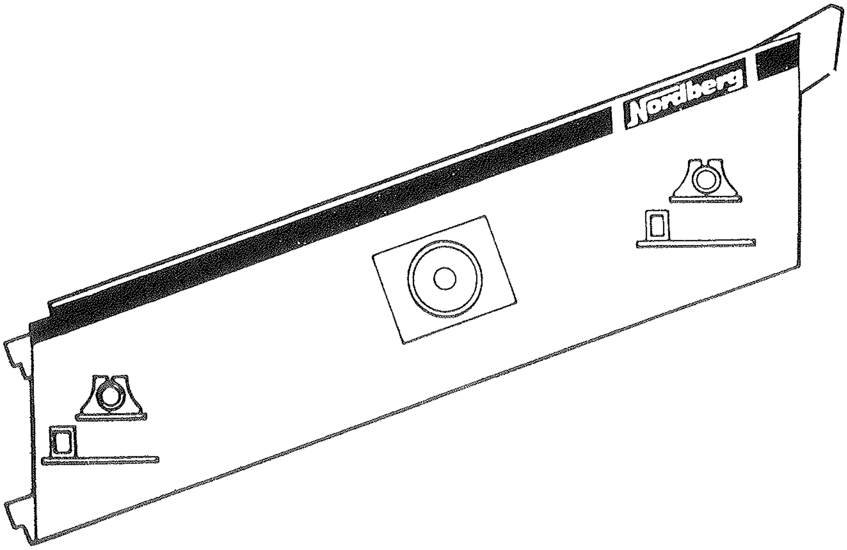
Screens



INTRODUCTION TO SCREEN AND SCREENING

A simple definition of a "screen" is a machine with a surface(s) used to classify materials by size.

Screening is defined as "The mechanical process which accomplishes a division of particles on the basis of size and their acceptance or rejection by a screening surface."

Knowledge of screening comes mainly from experience. However, through experiment, test facilities and compilation of field data, reliable criteria has been developed by screen manufacturers. This factual data is now tabulated for use in selecting the type and size of screen best suited for the job.

The most common application of a vibrating screen is to separate an unconfined conglomerate of materials into different size fractions. Other popular uses of screens are scalping, washing, dewatering and dedusting. A review of the duty is essential to know the type of screen to recommend. When this is established, the capacity chart is then used to determine the size unit required.

Nordberg supplies different types of screens, each designed for a specific range of duty. Occasionally there is a choice between the types we offer. In these cases when there is doubt, you can rely on Nordberg experience to help you make the selection.

Nordberg Screen

We begin with a very brief description of the Nordberg screen line. Refer to the literature for further details.

Nordberg Heavy-Duty Two Bearing Inclined Screens

The Nordberg heavy-duty two bearing inclined screen is most often used in general screening service. It is the type that is best suited for a wide range of applications. The vibrating assembly consists of a shaft mounted in two bearings with each bearing being supported by one of the side plates. This design provides maximum stroke with minimum flexure of the shaft and side plates. Additional eccentric weights can be bolted to both the flywheel and V-belt sheave to change the stroke when desired. When the shaft is rotated, it produces a circular vibrating motion. The two bearing screen is normally downsloped 20° but can operate in a range from approximately 15° to 30° from the horizontal. There are many features in the Nordberg two bearing screen which should be used to promote its sale over competitive units. The screen is available in sizes from 2' wide x 3' long through 8' wide x 24' long in single, double and tripe deck models.

Nordberg Heavy-Duty Four Bearing Inclined Screens

The Nordberg four bearing screen is similar in design to the two bearing unit with one major exception. On the four bearing screen, the eccentric shaft serves as both a crank arm and a counter balance. It is mounted on two outboard bearings (main bearings) attached to a stationary base (main frame). The screen body is supported partially by the eccentric shaft which is attached to side plates by side plate bearings (eccentric bearings) and partially by springs at each corner of the screen. The eccentric shaft is balanced by counterweighting it 180° out-of-phase with the screen so that little, if any, vibration is transferred to the main frame. The Nordberg four bearing screen is a positive action machine. The motion created is of constant amplitude and is not affected by the amount of material on the screen. It will not dampen under heavy loads, provided there is sufficient horsepower to drive it.

The motion on the four bearing screen is circular. Like the two bearing screen it should be installed at a downslope of from 15° to 30° to effect material travel.

SCREEN INQUIRY SHEET

SCREEN INQUIRY SHEET

In order that we may be fully acquainted with the conditions under which the screen is to operate, please fill in the answers to as many of the following questions as you can and mail to NORDBERG INC.

What is material to be screened ______

Characteristics of material: Wt. (per cu. ft.) ______ surface moisture ______%

description of particle shape ______

Size of infeed: minimum ______ maximum ______

Is slotted screen opening permissible? Yes ______ No ______

Product Size Specifications*

OVER Top Screen ______

OVER 2nd Screen ______

OVER 3rd Screen ______

THRU 3rd Screen ______

* When product size must meet particular specification, attach a separate sheet listing specific requirements.

SIEVE ANALYSIS

Opening	% Passing

Feedrate Specifications:

(including circulating load if applicable)

TPH (normal) ______ TPH (average) ______

Material conditions during screening:

For Dry screening: Very Dry ______ Damp ______ Sticky ______ Clayey ______

Hot ______ Specify temp in °F ______

Does material tend to blind ______? Plug ______?

For Wet screening: Check one

Material fed dry, water sprayed on screen* ______

Slurry feed, water sprayed on screen* ______

Slurry feed, no water sprayed on screen ______

*Specify flow ______ GPM; pressure ______ PSI

Maximum % surface moisture allowable in screened product

From Top Screen ______ %

From 2nd Screen ______ %

From 3rd Screen ______ %

From 3rd Screen ______ %

NORDBERG INC., MILWAUKEE, WISCONSIN, U.S.A.

Being a balanced unit, the four bearing screen starts and stops smoothly.

The four bearing screen is used primarily in mining applications.

The Nordberg vibrating mechanism incorporates a machined solid steel shaft which adds greatly to the strength of the vibrating assembly and prevents "cross haul", or the tendency for one side to lead the other. The result is smoother performance and longer bearing life.

The four bearing screen is available in sizes from 2' wide x 3' long through 8' wide x 24' long in single, double and triple deck models.

Nordberg Heavy-Duty Scalping Screens
Nordberg heavy-duty vibrating scalpers are designed to handle run-of-quarry or run-of-mine material. Nordberg scalpers are built with a fabricated sub-deck, covered by perforated plate, rail type decks with tapered longitudinal openings, or cast steel decks with square openings. The plate and cast decks can be supplied with or without wear bars. Scalpers with rail type decks can be furnished with replaceable wear caps.

Nordberg scalpers are available in both two bearing and four bearing models. Superior design, based on long experience, is combined with quality workmanship to provide a machine unbeatable in performance . . . operating in many instances for 24 hours per day with negligible downtime.

Discuss your scalping problem with a Nordberg Application Specialist. Nordberg scalpers are made in sizes to handle a few tons to more than 6,000 tons per hour.

Nordberg High Speed Two Bearing Inclined Screen
The high speed screen features an inclined deck design with overhead mounted two bearing vibrator unit for screening of most fine materials. When equipped with optional high capacity screen deck, the unit can effectively process moist, sticky material. This unit can be inclined to suit your application without any adjustment required because of unique shear mount support design. This machine features a variable stroke mechanism and, depending on the stroke, can operate at speeds up to 3,000 RPM. It is available in sizes from 3' wide x 6' long to 4' wide x 10' long in single and double deck models.

Nordberg Heavy-Duty Horizontal Screens
Horizontal screens are used primarily where headroom is at a premium, close sizing of medium sized materials is desired or dewatering of material is required.

Vibration of the horizontal screen is achieved through the use of two eccentric shafts rotating in opposite directions and mounted so that the line of action between them passes through the center of gravity of the screen assembly. The resultant force is essentially straight line or slightly elliptical at an angle of approximately 45° with the horizontal in the direction of material flow.

The horizontal screen is available in sizes from 4' wide x 8' long through 8' wide x 24' long in single, double and triple deck models.

Screen Selection
There are many factors to consider in selecting the proper screen. Most important is a review of the duty the screen is expected to handle. Certain facts must be known and to make this step easier we developed a screen inquiry sheet (shown on the following page). This provides a guide to obtain necessary information to intelligently make a recommendation.

The inquiry sheet is included in some of the screen bulletins and is available in pad form as well. Use this sheet whenever you have a screen inquiry. Send a copy of the completed form to Nordberg for review and possible follow-up assistance when needed.

HEAVY-DUTY GP SCREEN SPECIFICATIONS

Description of Basic Unit:
Nordberg Heavy-Duty GP Screen with sloped type sideplates, backplates, discharge lips, all 4 long modular type bolt-in-trays and tension plates (except 14 long screens), grease lubricated vibrator (except 8 wide screens are oil lubricated), extra heavy pipe support tubes, base mounting spring suspension (overhead suspension optional at extra price), friction checks, V-belt drive consisting of 2 screen sheaves and one motor sheave, but less screen surface, V-belts, motor and motor controls.

Size	No. of Decks	Recommended Motor Horsepower and V-belts									Approx. Shipping Weight	
		1/2" Throw @ 600 RPM			3/8" Throw @ 800 RPM			1/4" Throw @ 1000 RPM				
		HST	NST	V-Belt	HST	NST	V-Belt	HST	NST	V-Belt	(Lbs.)	(Kgs.)
4'x14'	2	10	20	C-112	10	15	C-112	7.5	15	C-112	9,470	4260
	3	15	20	C-112	10	20	C-112	10	15	C-112	11,340	5100
4'x16'	2	10	20	C-120	10	15	C-128	10	15	C-128	9,700	4365
	3	15	25	C-120	15	20	C-120	10	20	C-120	11,670	5250
5'x12'	2	10	20	C-85	10	15	C-85	10	15	C-90	9,140	4115
	3	15	25	C-81	15	20	C-85	10	15	C-85	10,700	4815
5'x14'	2	15	20	C-112	15	20	C-112	10	15	C-112	10,250	4615
	3	20	25	C-112	15	25	C-112	15	20	C-112	12,360	5565
5'x16'	2	15	25	C-120	15	20	C-128	10	15	C-128	10,480	4720
	3	20	25	C-120	20	25	C-120	15	20	C-120	12,690	5710
6'x12'	2	15	20	C-85	15	20	C-85	10	20	C-90	9,330	4200
	3	20	25	C-81	20	25	C-85	15	20	C-85	12,210	5495
6'x14'	2	15	25	C-112	15	20	C-112	10	15	C-112	11,630	5235
	3	20	25	C-112	20	25	C-112	15	20	C-112	14,080	6340
6'x16'	1	15	20	C-120	10	15	C-128	10	15	C-128	10,520	4735
	2	20	25	C-120	15	20	C-128	15	20	C-128	12,080	5440
	3	20	30	C-112	20	25	C-112	15	25	C-120	14,650	6595
6'x20'	1	15	20	C-144	15	20	C-144	10	15	C-144	11,790	5310
	2	20	25	C-144	20	25	C-144	15	20	C-144	13,780	6205
	3	25	40	C-144	25	30	C-144	20	55	C-144	17,190	7735
8'x16'	1	20	30	C-120	20	25	C-120	20	25	C-120	17,330	7800
	2	30	40	C-120	25	30	C-120	25	30	C-120	19,870	8945
	3	40	50	C-112	40	50	C-120	40	50	C-120	24,240	10910
8'x20'	1	25	30	C-158	20	30	C-158	20	30	C-158	18,230	8205
	2	30	50	C-158	30	40	C-158	30	40	C-158	21,400	9630
	3	40	60	C-144	40	50	C-144	40	50	C-144	26,390	11875

MOTOR STYLES—
HST = High Starting Torque
NST = Normal Starting Torque

NUMBER OF V-BELTS—
3 V-Belts Sizes through 6' x 16' Two Deck
5 V-Belts Sizes 6' x 16' Three Deck and Larger

Drive to be downhill on 12' long screens.

STANDARD TRAY ARRANGEMENTS
12' Screens — 4' + 4' + 4'
14' Screens — 4' + 4' + 6'
16' Screens — 4' + 4' + 4' + 4'
20' Screens — 4' + 4' + 4' + 4' + 4'

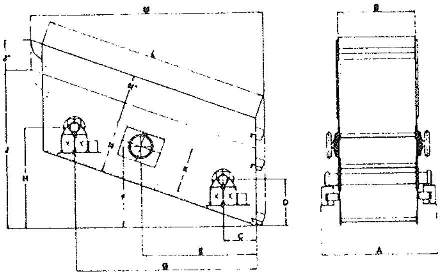
Use Pivot Motor Base, Locate Motor Downhill (Discharge End)

GP AND EHD SCREEN DIMENSIONS

Single, Double and Triple Deck, Mounted at 20° Slope

Single deck screens are available and are dimensionally identical to the double deck. Structural spacers are installed in place of the lower decks.

Note: All dimensions are approximate and subject to change without notice. Do not use for construction purposes.



DIMENSION	SIZE (Length x Width) 4' X 12'	5' X 12'	6' X 12'	4' X 14'	5' x 14'	6' X 14'
A	6'5-3/4"	7'5-3/4"	8'5-3/4"	6'5-3/4"	7'5-3/4"	8'5-3/4"
B	4'0"	5'0"	6'0"	4'0"	5'0"	6'0"
C	2'0-13/16"	2'0-13/16"	2'0-13/16"	2'0-13/16"	2'0-13/16"	2'0-13/16"
D	2'11-13/16"	2'11-13/16"	2'11-13/16"	2'11-13/16"	2'11-13/16"	2'11-13/16"
E	6'4-13/16"	6'4-13/16"	6'4-13/16"	7'4-1/16"	7'4-1/16"	7'4-1/16"
F	4'10-3/16"	2'10-3/16"	2'10-3/16"	5'2-5/16"	5'2-5/16"	5'2-5/16"
G	9'8-15/16"	9'8-15/16"	9'8-15/16"	11'7-15/16"	11'7-15/16"	11'7-15/16"
H	5'9-3/8"	5'9-3/8"	5'9-3/8"	6'5-3/4"	6'5-3/4"	6'5-3/4"
J*	11'5-7/8"	11'5-7/8"	11'5-7/8"	12'2-1/16"	12'2-1/16"	12'2-1/16"
J	9'6-7/16"	9'6-7/16"	9'6-7/16"	10'2-5/8"	10'2-5/8"	10'2-5/8"
K	2'10-15/16"	2'10-15/16"	2'10-15/16"	2'10-15/16"	2'10-15/16"	2'10-15/16"
L	12'6-3/4"	12'6-3/4"	12'6-3/4"	14'6-3/4"	14'6-3/4"	14'6-3/4"
M	13'1-5/16"	13'1-5/16"	13'1-5/16"	14'11-15/16"	14'11-15/16"	14'11-15/16"
N	6'6"	6'6"	6'6"	6'6"	6'6"	6'6"
N	4'8"	4'8"	4'8"	4'8"	4'8"	4'8"

DIMENSION	SIZE (Length x Width) 4' X 16'	5' X 16'	6' X 16'	6' X 20'	8' x 16'	8' X 20'
A	6'5-3/4"	7'5-3/4"	8'5-3/4"	8'5-3/4"	10'5-3/4"	10'5-3/4"
B	4'0"	5'0"	6'0"	6'0"	8'0"	8'0"
C	2'0-13/16"	2'0-13/16"	2'0-13/16"	2'0-13/16"	24"	24"
D	2'11-13/16"	2'11-13/16"	2'11-13/16"	2'11-13/16"	3'8-7/8"	3'8-7/8"
E	8'4-1/4"	8'4-1/4"	8'4-1/4"	10'5-11/16"	8'8-1/8"	10'6-5/8"
F	5'7-1/8"	5'7-1/8"	5'7-1/8"	6'2"	6'0-3/8"	6'8-9/16"
G	13'6-7/16"	13'6-7/16"	13'6-7/16"	17'3-5/8"	13'5-5/8"	17'2-3/4"
H	7'5-3/8"	7'5-3/8"	7'5-3/8"	8'6-1/4"	7'10-15/16"	9'3-9/16"
J*	12'9-13/16"	12'9-13/16"	12'9-13/16"	14'2-11/16"	13'8-7/16"	15'10-3/16"
J	10'10-3/8"	10'10-3/8"	10'10-3/8"	12'3-1/4"	11'6-7/8"	13'8-5/8"
K	2'10-15/16"	2'10-15/16"	2'10-15/16"	2'10-15/16"	3'5-11/16"	3'5-11/16"
L	16'6-3/4"	16'6-3/4"	16'6-3/4"	20'6-3/4"	16'8-3/4"	20'8-3/4"
M	16'10-7/16"	16'10-7/16"	16'10-7/16"	21'10-7/16"	17'5-1/2"	22'5-9/16"
N*	6'6"	6'6"	6'6"	6'6"	7'6"	7'6"
N	4'8"	4'8"	4'8"	4'8"	5'6"	5'6"

*This dimension for triple deck screen.

EXTRA HEAVY-DUTY EHD SCREEN SPECIFICATIONS

Description of Basic Unit:
Nordberg Extra Heavy-Duty (EHD) Screen including sloped type sideplates, grease lubricated vibrator assembly with bolt-on unbalance weights (8′ is oil lubricated), series 33 bearings, modular type bolt-in surface support trays (advise factory of specs. on surface to be used), tension plates, extra heavy pipe support tubes, base mounting spring suspension (overhead suspension optional at extra price), friction checks, backplates, bolt-in discharge lips, V-belt drive consisting of 2 screen sheaves and one motor sheave, AR steel liners on all discharge lips, on sideplates over top deck, on top deck tension plates, but less screen surface, V-belts, motor and motor controls.

Size	No. of Decks	Recommended Motor Horsepower and V-belts: 1/2" Throw @ 660 RPM			3/8" Throw @ 800 RPM			1/4" Throw @ 1000 RPM			Approx. Shipping Weight	
		HST	NST	V-Belt	HST	NST	V-Belt	HST	NST	V-Belt	(Lbs.)	(Kgs.)
4′x12′	1	10	20	C-85	10	20	C-85	10	15	C-90	8,040	3618
	2	15	20	C-85	10	20	C-85	10	15	C-90	9,050	4072
	3	20	25	C-81	15	20	C-85	15	20	C-85	10,650	4792
5′x12′	1	10	20	C-85	10	20	C-85	10	20	C-90	9,100	4095
	2	15	25	C-85	15	20	C-85	10	20	C-90	10,200	4590
	3	20	30	C-81	20	25	C-85	15	20	C-85	12,300	5535
5′x16′	1	15	25	C-120	15	20	C-128	10	20	C-128	10,500	4725
	2	20	30	C-120	20	25	C-128	15	20	C-128	11,600	5220
	3	25	30	C-120	25	30	C-120	20	25	C-120	14,200	6390
6′x12′	1	15	20	C-85	15	20	C-85	10	20	C-90	10,300	4635
	2	20	25	C-85	20	25	C-85	15	25	C-90	11,400	5130
	3	25	30	C-81	20	30	C-81	20	25	C-85	13,500	6075
6′x16′	1	20	25	C-120	15	20	C-128	15	20	C-128	11,700	5265
	2	25	30	C-120	20	25	C-128	20	25	C-128	13,200	5940
	3	25	40	C-109	25	30	C-112	20	30	C-120	16,700	7515
6′x20′	1	20	25	C-144	20	25	C-144	15	20	C-144	13,600	6120
	2	25	30	C-136	25	30	C-144	20	25	C-144	15,200	6840
	3	30	40	C-136	30	40	C-144	25	30	C-144	19,400	8730
8′x16′	1	25	40	C-120	25	30	C-120	25	30	C-120	18,600	8370
	2	40	50	C-120	30	40	C-120	30	40	C-120	22,000	9900
	3	40	50	C-112	40	50	C-120	40	50	C-120	26,400	11800
8′x20′	1	25	40	C-158	25	40	C-158	25	40	C-158	20,500	9225
	2	40	60	C-158	40	50	C-158	40	50	C-158	24,600	11070
	3	40	60	C-144	40	50	C-144	40	50	C-144	29,700	13365

MOTOR STYLES—
HST = High Starting Torque
NST = Normal Starting Torque

NUMBER OF V-BELTS—
3 V-Belts Sizes through 6′ x 16′ Two Deck
5 V-Belts Sizes 6′ x 16′ Three Deck and Larger

Drive to be downhill on 12′ long screens.

STANDARD TRAY ARRANGEMENTS
12′ Screens — 4′ + 4′ + 4′
16′ Screens — 4′ + 4′ + 4′ + 4′
20′ Screens — 4′ + 4′ + 4′ + 4′ + 4′

Use Pivot Motor Base, Locate Motor Downhill (Discharge End)

NORDBERG MODEL N2HD
HEAVY-DUTY TWO BEARING SCREENS

DESCRIPTION OF BASIC SCREEN
Nordberg Two Bearing Heavy Duty Model N2HD inclined vibrating screen with sloped type sideplates, fabricated one piece surface support frame(s) bolted between side plates for side tensioning (single crown configuration on 2', 3', 4', 5', 6' widths and double crown configuration on 7', and 8' widths) woven wire screen cloth sections, backplates, discharge lips, tension plates, (grease or oil) lubricated adjustable throw vibrator assembly, base or overhead spring suspension mountings located at each corner, screen sheave, motor sheave, V-belts, pivot motor base, V-belt guard, flywheel guard, but not including screen surface, motor or motor controls.

See pages 13-9 thru 13-11 for specifications.

NORDBERG MODEL N2HD
DUAL MECHANISM TWO BEARING SCREENS

DESCRIPTION OF BASIC SCREEN
Nordberg Dual Mechanism Two Bearing N2HD inclined vibrating screen with sloped type sideplates, fabricated one piece surface support frame(s) bolted between side plates for side tensioning woven wire screen cloth sections, backplates, discharge lips, tension plates, oil lubricated adjustable throw vibrator assembly, base spring suspension mountings located at each corner, screen sheave, motor sheave, V-belts, pivot motor base, V-belt guard, flywheel guard, but not including screen surface, motor or motor controls.

See pages 13-12 thru 13-13 for specifications.

NORDBERG MODEL N4HD
FOUR BEARING SCREENS

DESCRIPTION OF BASIC SCREEN
Nordberg Four Bearing Heavy Duty Model N4HD inclined vibrating screen with sloped type sideplates, fabricated one piece surface support frame(s) bolted between side plates for side tensioning (single crown configuration on 2', 3', 4', 5', 6' widths and double crown configuration on 7', and 8' widths) woven wire screen cloth sections, backplates, discharge lips, tension plates, (grease or oil) main bearings, eccentric bearings, full length stationary I-beam sub base for supporting the vibrating frame with rubber blocks or steel coil springs located at each corner, screen sheave, motor sheave, V-belts, motor base, V-belt guard, flywheel guard, but not including screen surface, motor or motor controls.

See pages 13-14 thru 13-19 for specifications.

NORDBERG MODEL NHZ
HORIZONTAL SCREENS

DESCRIPTION OF BASIC SCREEN
Nordberg Model NHZ Horizontal Vibrating screen with feed box having mild steel liners, fabricated one piece surface support frame(s) bolted between side plates for side tensioning (single crown configuration on 2', 3', 4', 5', 6' widths and double crown configuration on 7', and 8' widths) woven wire screen cloth sections, backplates, discharge lips, tension plates, overhead mounted oil lubricated vibrator assembly, base spring suspension mountings located at each corner, screen sheave, motor sheave, V-belts, pivot motor base, V-belt guard, but not including screen surface, motor or motor controls.

See pages 13-20 thru 13-25 for specifications.

NORDBERG MODEL NHZ
LOW PROFILE HORIZONTAL SCREENS

DESCRIPTION OF BASIC SCREEN
Nordberg Model NHZ Horizontal Vibrating screen with feed box having mild steel liners, fabricated one piece surface support frame(s) bolted between side plates for side tensioning woven wire screen cloth sections, backplates, discharge lips, tension plates, dual-shaft drive built into screen body with oil lubricated vibrator assembly, base spring suspension mountings located at each corner, screen sheave, motor sheave, V-belts, pivot motor base, V-belt guard, but not including screen surface, motor or motor controls.

See pages 13-26 thru 13-27 for specifications.

NORDBERG MODEL N2HF
TWO BEARING HIGH SPEED SCREENS

DESCRIPTION OF BASIC SCREEN
Nordberg Two Bearing High Speed Model N2HF inclined vibrating screen with fabricated one piece surface support frame(s) bolted between side plates for side tensioning woven wire screen cloth sections, backplates, feed box with mild steel wear liners, discharge lip(s), tension plates, adjustable throw oil lubricated vibrator assembly with 65 mm bearings, full length stationary main frame for supporting vibrating frame through rubber mounts located at each corner, screen sheave, motor sheave, V-belts, motor base support stand, adjustable motor slide base, V-belt guard, but not including screen surface, motor or motor controls.

See pages 13-28 thru 13-29 for specifications.

NORDBERG MODEL N2HD
HEAVY-DUTY TWO BEARING SCREENS
SINGLE DECK SPECIFICATIONS

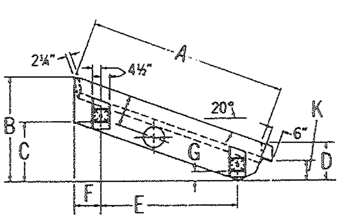
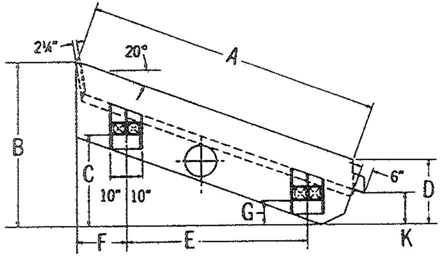


FIGURE I



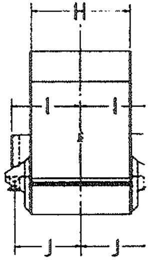


FIGURE II

Single Deck

SIZE feet	MECH.	APPX. WT., lbs.	H.P.*	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E ft.-in.	F ft.-in.	G ft.-in.	H ft.-in.	I ft.-in.	J ft.-in.	K ft.-in.
3x6	M45	1,100	1	6-2½	3-8¼	1-9⅝	1-7⅜	3-9⅛	1-1¾	0-5¼	3-2	1-11¼	2-1	0-9⅞
3x8	M45	1,300	1	8-2½	4-4⅜	2-5⅞	1-7⅜	5-7⅝	1-1¾	0-5¼	3-2	1-11¼	2-1	0-9⅞
4x8	M70	3,000	3	8-3⅞	5-7	2-6⅝	2-9	5-7⅝	1-2¾	0-5½	4-2	2-7½	2-7	1-4
4x10	M70	3,300	5	10-3⅞	6-2¾	3-1¾	2-9	5-7⅝	2-2	1-1⅛	4-2	2-7½	2-7	1-4
4x12	M95	4,000	7.5	12-3⅞	6-11	3-10¼	2-9	7-6¼	2-2	1-1⅜	4-2	2-10½	2-7	1-4
5x12	M110A	6,400	5	12-3⅞	7-8⅝	3-9½	3-6¾	7-6¼	2-1¼	1-⅝	5-2	3-6⅞	3-3⅞	2-1¾
5x14	M110A	7,000	7.5	14-3⅞	8-4⅞	4-6	3-6¾	9-4¾	2-1¼	1-⅝	5-2	3-6⅞	3-3⅞	2-1¾
5x16	M110A	7,900	7.5	16-3⅞	9-1⅛	4-10¼	3-6¾	9-4¾	3-½	1-5¼	5-2	3-6⅞	3-3⅞	2-1¾
6x12	M110A	7,152	5	12-3⅞	7-8⅝	3-10	3-6¾	7-6¼	2-1¼	1-1⅛	6-2	4-⅞	3-9⅞	2-1¾
6x16	M110A	8,160	7.5	16-3⅞	9-1⅛	4-10¼	3-6¾	9-4¾	3-½	1-5¼	6-2	4-⅞	3-9⅞	2-1¾
6x20	M110A	9,276	10	20-3⅞	10-5½	6-2¾	3-6¾	13-1⅞	3-½	1-5¼	6-2	4-⅞	3-9⅞	2-1¾
7x14	M110A	9,808	10	14-4¾	8-9⅝	4-9	3-11⅜	9-4¾	2-1¾	1-3⅞	7-2	4-6⅞	4-3⅞	2-6½
7x16	M110A	10,450	10	16-4¾	9-5⅞	5-1	3-11⅜	9-4¾	3-1	1-8	7-2	4-6⅞	4-3⅞	2-6½
7x20	M120A	12,770	15	20-4¾	10-10¼	6-5½	3-11⅜	13-1⅞	3-1	1-8	7-2	4-10⅝	4-3⅞	2-6½
8x16	M110A	12,015	15	16-5⅜	9-7⅜	4-10½	4-⅝	9-4¾	3-1⅜	1-5½	8-2	5-⅞	4-9⅞	2-5
8x20	M120A	14,680	15	20-5⅜	10-11¾	6-3⅛	4-⅝	13-1⅞	3-1⅜	1-5⅝	8-2	5-4⅜	4-9⅞	2-5
8x24	M120A	15,940	20	24-5⅜	12-4	7-⅜	4-⅝	16-11	3-1⅜	0-10½	8-2	5-4⅜	4-9⅞	2-5

Note: Figure I configuration applies only to sizes 3x6 through 4x8. Figure II configuration applies to all others.

Dimensions are approximate.

NORDBERG MODEL N2HD
HEAVY-DUTY TWO BEARING SCREENS
DOUBLE DECK SPECIFICATIONS

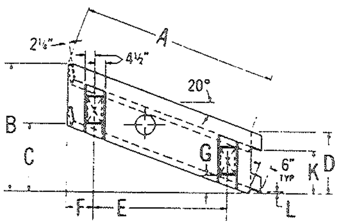


FIGURE I

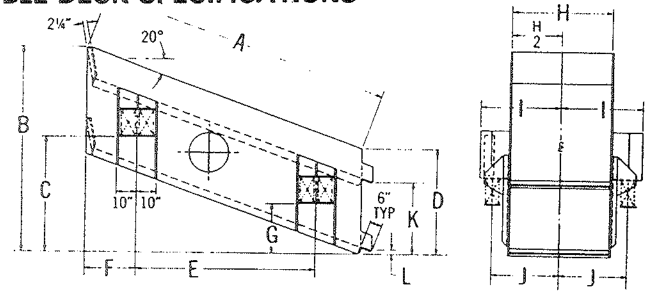


FIGURE II

Double Deck

SIZE feet	MECH.	APPX. WT., lbs.	H.P.*	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E ft.-in.	F ft.-in.	G ft.-in.	H ft.-in.	I ft.-in.	J ft.-in.	K ft.-in.	L in.
3x6	M70	1,900	1	6-2½	4-8½	2-10⅜	2-7⅝	3-9⅛	1-1¾	1-5⅞	3-2	2-1½	2-1	1-10⅛	¾
3x8	M70	2,200	2	8-2½	5-4⅜	2-8½	2-7⅝	5-7⅝	1-1¾	0-7⅞	3-2	2-1½	2-1	1-10⅛	¾
4x8	M110A	5,500	5	8-3⅞	7-3¼	3-11⅜	4-5¾	5-7⅝	1-2¾	1-9¼	4-2	3-⅞	2-10½	3-⅞	1¾
4x10	M110A	6,100	7.5	10-3⅞	7-11½	4-2⅜	4-5¾	5-7⅝	2-2	2-1¾	4-2	3-⅞	2-10½	3-⅞	1¾
4x12	M110A	6,700	7.5	12-3⅞	8-7⅝	4-10⅞	4-5¾	7-6¼	2-2	2-2	4-2	3-⅞	2-10½	3-⅞	1¾
5x12	M110A	7,700	7.5	12-3⅞	8-10⅝	4-11⅞	4-8¾	7-6¼	2-1¼	2-3	5-2	3-6⅛	3-3⅞	3-3¾	3⅝
5x14	M110A	8,700	7.5	14-3⅞	9-6¾	5-8⅜	4-8¾	9-4¾	2-1¼	2-3¼	5-2	3-6⅛	3-3⅞	3-3¾	3⅝
5x16	M110A	9,700	10	16-3⅞	10-3	6-⅜	4-8¾	9-4¾	3-½	2-7¼	5-2	3-10 5/16	3-3⅞	3-3¾	3⅝
6x12	M110A	9,200	10	12-3⅞	8-10⅝	5-¼	4-8¾	7-6½	2-1¼	2-3¼	6-2	4-⅞	3-9⅞	3-3¾	3⅝
6x16	M110A	10,500	10	16-3⅞	10-3	6-⅜	4-8¾	9-4¾	3-½	2-7¼	6-2	4-⅞	3-9⅞	3-3¾	3⅝
6x20	M120A	13,000	15	20-3⅞	11-7½	7-4⅞	4-8¾	13-1⅞	3-½	2-7⅜	6-2	4-4 5/16	3-9⅞	3-3¾	3⅝
7x14	M120A	13,800	25	14-4¾	10-2⅜	6-1⅞	5-4½	9-4¾	2-1¾	2-8⅞	7-2	4-10⅝	4-3⅞	3-11½	5½
7x16	M120A	14,900	25	16-4¾	.10-11	6-6	5-4½	9-4¾	3-1	3-1	7-2	4-10⅝	4-3⅞	3-11½	5½
7x20	M120A	17,000	30	20-4¾	12-3⅜	7-3½	5-4½	13-1⅞	3-1	2-6	7-2	4-11⅜	4-3⅞	3-11½	5½
8x16	M120A	16,800	30	16-5⅜	11-3¾	6-0	5-9⅛	9-4¾	3-1⅜	2-7	8-2	5-4⅜	4-9⅞	4-1½	6⅜
8x20	M140A	20,500	30	20-5⅜	12-8⅛	7-4¾	5-9⅛	13-1⅞	3-1⅜	2-7¼	8-2	5-5⅜	4-9⅞	4-1½	6⅜
8x24	M140A	21,600	40	24-5⅜	14-½	8-9¼	5-9⅛	16-11	3-1⅜	2-7⅜	8-2	5-5⅜	4-9⅞	4-1½	6⅛

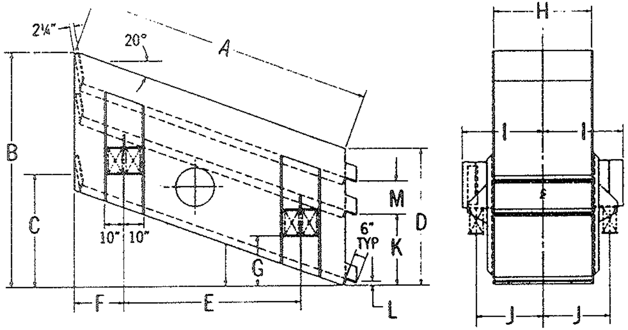
Note: Figure I configuration applies only to sizes 3'x6' and 3'x8'. Figure II configuration applies to all others.

*1800 RPM, NEMA C motor

NORDBERG MODEL N2HD

HEAVY-DUTY TWO BEARING SCREENS

TRIPLE DECK SPECIFICATIONS



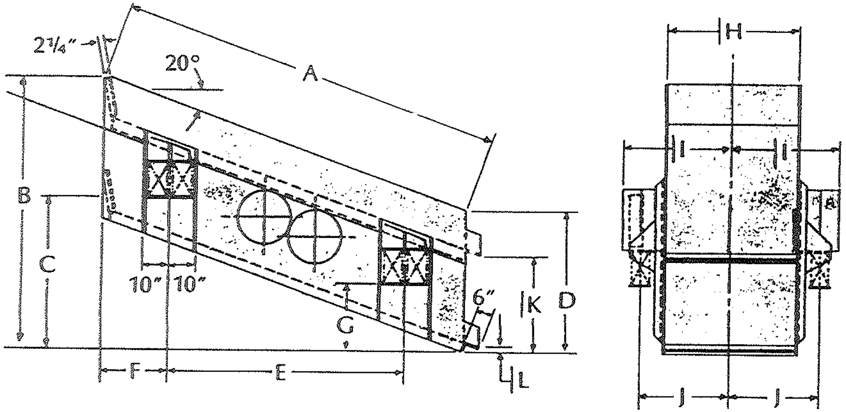
Triple Deck

SIZE feet	MECH.	APPX. WT., lbs.	H.P.*	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E ft.-in.	F ft.-in.	G ft.-in.	H ft.-in.	I ft.-in.	J ft.-in.	K ft.-in.	L in.	M ft.-in.
4x8	M110A	6,600	7.5	8-3⅞	8-8¼	3-10½	5-10¾	5-7⅝	1-2¾	1-9⅞	4-2	3-⅛	2-10½	3-⅞	1¾	1-5
4x10	M120A	7,800	7.5	10-3⅞	9-4½	4-2⅝	5-10¾	5-7⅝	2-2	2-2	4-2	3-4 5/16	2-10½	3-⅞	1¾	1-5
4x12	M120A	9,000	10	12-3⅞	10-¾	4-11¼	5-10¾	7-6¼	2-2	2-2⅜	4-2	3-4 5/16	2-10½	3-⅞	1¾	1-5
5x12	M120A	11,000	10	12-3⅞	10-5¾	5-0	6-3⅞	7-6¼	2-1¼	2-3⅛	5-2	3-10 5/16	3-3⅞	3-3¾	3⅝	1-7⅛
5x14	M120A	12,300	15	14-3⅞	11-2	5-8⅜	6-3⅞	9-4¾	2-1¼	2-3¼	5-2	3-10 5/16	3-3⅞	3-3¾	3⅝	1-7⅛
5x16	M120A	12,700	20	16-3⅞	11-10¼	6-¼	6-3⅞	9-4¾	3-½	2-7¼	5-2	3-10 5/16	3-3⅞	3-3¾	3⅝	1-7⅛
6x12	M120A	12,800	15	12-3⅞	10-5¾	5-¼	6-3⅞	7-6¼	2-1¼	2-3⅛	6-2	4-4 5/16	3-9⅞	3-3¾	3⅝	1-7⅛
6x16	M120A	14,900	20	16-3⅞	11-10¼	6-⅜	6-3⅞	9-4¾	3-½	2-7⅜	6-2	4-4 5/16	3-9⅞	3-3¾	3⅝	1-7⅛
6x20	M140A	17,900	30	20-3⅞	13-2⅝	7-¾	6-3⅞	13-1⅞	3-½	2-3¼	6-2	4-5 5/16	3-9⅞	3-3¾	3⅝	1-7⅛
7x14	M120A	18,100	30	14-4¾	12-0	5-7	7-1¾	9-4¾	2-1¾	2-2	7-2	4-10⅜	4-3⅞	3-11½	5½	1-9¼
7x16	M140A	20,100	30	16-4¾	12-8¼	5-11⅛	7-1¾	9-4¾	3-1	2-6⅛	7-2	4-11⅜	4-3⅞	3-11½	5½	1-9¼
7x20	M160A	24,900	30	20-4¾	14-⅝	7-3⅞	7-1¾	13-1⅞	3-1	2-6⅜	7-2	4-11⅜	4-3⅞	3-11½	5½	1-9¼
8x16	M160A	24,800	30	16-5⅜	13-2⅛	6-½	7-7½	9-4¾	3-1⅜	2-7⅜	8-2	5-5⅜	4-9⅞	4-1½	6⅜	1-10⅜
8x20	M160A	29,400	40	20-5⅜	14-6½	7-4⅞	7-7½	13-1⅞	3-1⅜	2-7½	8-2	5-5⅜	4-9⅞	4-1½	6⅜	1-10⅜
8x24	M160A	31,800	50	24-5⅜	15-10⅞	8-9½	7-7½	16-11	3-1⅜	2-7⅜	8-2	5-5⅜	4-9⅞	4-1½	6⅜	1-10⅜

*1800 RPM, NEMA C motor

Dimensions are approximate.
Allow 2 inch clearance around moving unit.
Other sizes also available. Consult the factory.

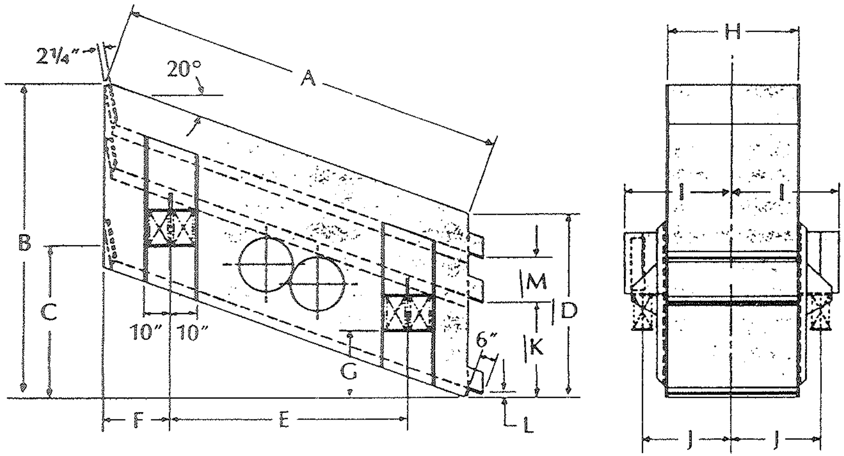
NORDBERG MODEL N2HD
DUAL MECHANISM TWO BEARING SCREENS
DOUBLE DECK SPECIFICATIONS



SIZE feet	Mech.	APPX. WT., lbs.	H.P.*	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E ft.-in.	F ft.-in.	G ft.-in.	H ft.-in.	I ft.-in.	J ft.-in.	K ft.-in.	L in.
8×20	DM140A	25,130	(2)20	20-5⅜	12-8⅛	7-4¾	5-9⅛	13-1⅞	3-1⅜	2-7¼	8-2	5-5⅜	4-9⅞	4-1½	6⅜
8×24	DM140A	28,230	(2)25	24-5⅜	14-½	8-9¼	5-9⅛	16-11	3-1⅜	2-7⅜	8-2	5-5⅜	4-9⅞	4-1½	6⅜

Dimensions are approximate.

NORDBERG MODEL N2HD
DUAL MECHANISM TWO BEARING SCREENS
TRIPLE DECK SPECIFICATIONS



SIZE feet	Mech.	APPX. WT., lbs.	H.P.*	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E ft.-in.	F ft.-in.	G ft.-in.	H ft.-in.	I ft.-in.	J ft.-in.	K ft.-in.	L in.	M ft.-in.
7×20	DM140A	28,100	(2)20	20-4¾	14-5/8	7-3⅞	7-1¾	13-1⅞	3-1	2-6⅜	7-2	4-11⅜	4-3⅞	3-11½	5½	1-9¼
8×16	DM140A	28,000	(2)20	16-5⅜	13-2⅛	6-½	7-7½	9-4¾	3-1⅜	2-7⅜	8-2	5-5⅜	4-9⅞	4-1½	6⅜	1-10⅜
8×20	DM140A	32,600	(2)25	20-5⅜	14-6½	7-4⅞	7-7½	13-1⅞	3-1⅜	2-7½	8-2	5-5⅜	4-9⅞	4-1½	6⅜	1-10⅜
8×24	DM140A	35,000	(2)30	24-5⅜	15-10⅞	8-9½	7-7½	16-11	3-1⅜	2-7⅝	8-2	5-5⅜	4-9⅞	4-1½	6⅜	1-10⅜

*Two motors required, 1800 RPM, NEMA C

Dimensions are approximate.

NORDBERG MODEL N4HD
FOUR BEARING SCREENS
SINGLE DECK SPECIFICATIONS (Continued)

4x8	2700	—	5	8-2 1/2	4 5/8	6-4 3/8	2-5	3-6 7/8	3 1/2	1-8 1/4	2-9 1/8	4-10 3/8	8	6-7 3/4	0-9 7/8	3 3/8	7-6 1/4	0-9 3/8	6-0	4-2	2-6 7/8	2-1 7/8
4x10	3100	—	5	10-2 1/2	4 5/8	7-5/8	3-1 1/4	3-6 7/8	3 1/2	1-8 1/4	4-5 3/4	5-7 1/8	10	8-6 1/4	0-9 7/8	3 3/8	3-5	0-9 3/8	6-0	4-2	2-6 7/8	2-1 7/8
4x12	5000	5	3	12-2 1/2	5 3/4	7-10 7/8	3-9 1/2	3-8 7/8	4 1/8	1-8 1/4	5-5	6-7 1/8	12	10-4 7/8	0-11 7/8	2 3/8	11-3 3/8	0-11 1/4	6-2	4-2	2-7 5/8	2-3 7/8
4x14	6500	5	5	14-2 1/2	6 1/2	8-10 7/16	4-5 5/8	4-5/16	5 1/8	1-8 1/4	6-4	7-7 1/8	14	12-3 3/4	1-3 5/16	1 3/8	13-1 7/8	1-2 1/8	6-3 1/2	4-2	2-8 9/16	2-7 5/16
5x10	6100	7.5	5	10-3 7/8	5 3/4	7-5 1/2	2-10 1/8	3-11 3/4	4 1/8	2-4 1/2	3-8	5-5	10	7-9 7/8	0-5	10 7/8	9-4 3/4	0-11 1/4	7-2	5-2	3-1 5/8	2-6 3/4
5x12	7700	7.5	7.5	12-3 7/8	6 1/2	8-2 9/16	3-6 3/8	4-7/16	4 1/8	2-4 1/2	4-7	6-5	12	9-8 1/2	0-5 11/16	10 5/8	11-3 3/8	0-11 1/4	7-3 1/2	5-2	3-2 9/16	2-7 7/16
5x14	8500	7.5	7.5	14-3 7/8	6 1/2	9-3 15/16	4-2 5/8	4-7/16	4 1/8	2-4 1/2	5-6 1/4	7-5	14	11-7	0-5 11/16	10 5/8	13-1 7/8	0-11 1/4	7-3 1/2	5-2	3-2 9/16	2-7 7/16
5x16	9300	10	7.5	16-3 7/8	6 1/2	9-3 1/4	4-10 3/4	4-3 3/8	5 1/8	2-4 1/2	6-5 3/4	8-5	16	13-5 1/2	0-8 5/8	8	15-3/8	1-2 1/8	8-11	5-2	3-2 9/16	2-10 3/8
6x12	8400	10	7.5	12-3 7/8	6 1/2	7-9	3-6 3/8	4-3 3/8	5 1/8	2-4 1/2	4-7 1/4	6-5	12	9-8 1/2	0-8 5/8	8	11-3 3/8	1-2 1/8	9-5	6-2	3-8 9/16	2-10 3/8
6x14	9300	10	10	14-3 7/8	6 1/2	9-1 1/2	4-2 5/8	4-3 3/8	5 1/8	2-4 1/2	5-6 1/2	7-5	14	11-7	0-8 5/8	8	13-1 7/8	1-2 1/8	9-5	6-2	3-8 9/16	2-10 3/8
6x16	10200	10	10	16-3 7/8	6 1/2	9-9 3/4	4-10 3/4	4-3 3/8	5 1/8	2-4 1/2	6-5 3/4	8-5	16	13-5 1/2	0-8 5/8	8	15-3/8	1-2 1/8	9-5	6-2	3-8 9/16	2-10 3/8
6x18	11100	15	10	18-3 7/8	6 1/2	10-6	5-7	4-3 3/8	5 1/8	2-4 1/2	7-5	9-5	18	15-4 1/8	0-8 5/8	8	16-11	1-2 1/8	9-5	6-2	3-8 9/16	2-10 3/8
6x20	13000	15	10	20-3 7/8	6 1/2	11-1/8	6-3 1/4	4-3 3/8	5 1/8	2-4 1/2	8-4 1/4	10-5	20	17-2 5/8	0-8 5/8	8	18-9 1/2	1-2 1/8	9-5	6-2	3-8 9/16	2-10 3/8
7x14	12300	15	10	14-4 3/4	6 1/2	9-4 3/4	4-1 3/8	4-6 1/2	5 1/8	2-9 3/8	5-3 3/4	7-6 1/8	14	11-3 3/4	0-7 1/8	11 3/4	13-1 7/8	1-2 1/8	10-1	7-2	4-2 9/16	3-1 5/8
7x16	13100	15	15	16-4 3/4	6 1/2	10-1	4-9 5/8	4-6 1/2	5 1/8	2-9 3/8	6-3	8-6 1/8	16	13-2 1/4	0-7 1/8	11 3/4	15-3/8	1-2 1/8	10-1	7-2	4-2 9/16	3-1 5/8
7x18	13200	20	15	18-4 3/4	6 1/2	10-9 1/8	5-5 3/4	4-6 1/2	5 1/8	2-9 3/8	7-2 3/8	9-6 1/8	18	15-3/4	0-7 1/8	11 3/4	16-11	1-2 1/8	10-1	7-2	4-2 9/16	3-1 5/8
7x20	15900	20	15	20-4 3/4	11 1/2	11-10	6-2	4-11 1/8	5 1/8	2-9 3/8	8-1 5/8	10-6 1/8	20	16-11 3/8	0-11 3/4	11 3/4	18-9 1/2	1-2 1/8	10-10	7-2	4-6	3-6 1/4
8x16	14900	20	15	16-5 3/8	6 1/2	10-4	4-10	4-10 1/8	5 1/8	2-8 7/8	6-5 1/2	8-7 7/8	16	13-3 3/8	0-9 1/2	11	15-3/8	1-2 1/8	11-1	8-2	4-8 9/16	3-2 1/2
8x18	16300	20	15	18-5 3/8	6 1/2	11-1	5-6 1/8	4-10 1/8	5 1/8	2-8 7/8	7-4 3/4	9-7 7/8	18	15-1 5/8	0-9 1/2	11	16-11	1-2 1/8	11-1	8-2	4-8 9/16	3-2 1/2
8x20	18500	25	15	20-5 3/8	11 1/2	12-1 7/8	6-2 3/8	5-2 3/4	5 1/8	2-8 7/8	8-4	10-7 7/8	20	17-1/4	1-2 1/8	11	18-9 1/2	1-2 1/8	11-10	8-2	5-0	3-7 1/8
8x24	20000	25	20	24-5 3/8	11 1/2	13-6 1/8	7-6 3/4	5-2 3/4	5 1/8	2-8 7/8	10-2 1/2	12-7 7/8	24	20-9 3/8	1-2 1/8	11	22-6 5/8	1-2 1/8	1-1	8-2	5-0	3-7 1/8

Note: *Fig I configuration applies only to sizes 2'x3' 3'x4' and 2'x6'. Fig II configuration applies to all others*

Dimensions are approximate.

NORDBERG MODEL N4HD
FOUR BEARING SCREENS
SINGLE DECK SPECIFICATIONS

Allow 2 inch clearance around moving unit

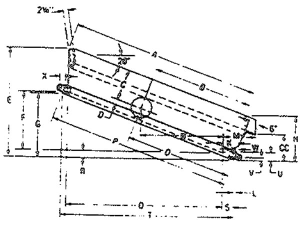


FIGURE I

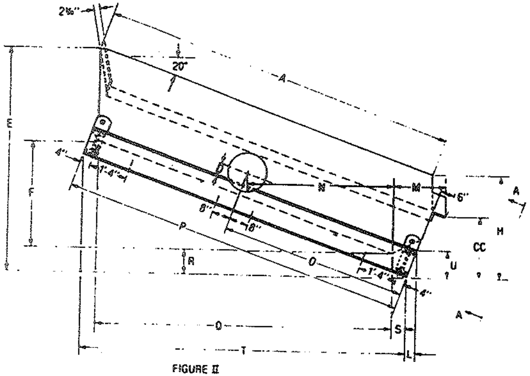
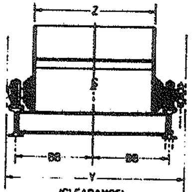


FIGURE II



(CLEARANCE)

VIEW AT "A-A"

SIZE feet	WGT lbs	H.P. STROKE ⅛	H.P. STROKE ¼	A ft.-in	D in	E ft.-in	F ft.-in	H ft.-in	L in.	M ft.-in.	N ft.-in	O ft.-in	P ft.	O ft.-in.	R ft.-in.	S in.	T ft.-in.	U ft.-in.	Y ft.-in.	Z ft.-in.	BB ft.-in.	CC ft.-in.
2x3	600	—	1	3-2½	3½	3-1½	0-9⅜	1-11¼	1¾	1-5	0-9¼	2-3¾	3	2-1⅝	0-5¾	4⅞	2-9⅞	0-4¾	3-3	2-2	1-4¼	1-1¾
2x4	700	—	1	4-2½	3½	3-5⅝	1-1½	1-11¼	1¾	1-5	1-2⅞	2-9⅝	4	3-⅞	0-5¾	4⅞	3-9⅛	0-4¾	3-3	2-2	1-4¼	1-1¾
2x6	900	—	2	6-2½	3½	4-⅛	1-9⅝	1-11¼	1¾	1-5	2-2¾	3-1¼	6	4-11⅜	0-3⅞	5½	5-7⅝	0-4¾	3-3	2-2	1-4¼	1-1¾
2x8	1700	—	3	8-2½	4⅝	5-2¼	2-5¾	2-5¼	3½	1-5	3-2	4-1¼	8	6-9⅞	0-9⅞	3⅜	7-6¼	0-9⅜	4-0	2-2	1-6⅞	1-7¾
3x6	1000	—	2	6-2½	3½	4-⅛	1-9⅝	1-11¼	1¾	1-5	2-2¾	3-1¼	6	4-11⅜	0-3⅞	5½	5-7⅝	0-4¾	4-3	3-2	1-10¼	1-1¾
3x8	1200	—	2	8-2½	3½	4-8¾	2-5¾	1-11¼	1¾	1-5	3-2	4-1¼	8	6-9⅞	0-3⅞	5½	7-6¼	0-4¾	4-3	3-2	1-10¼	1-1¾
3x10	2400	—	3	10-2½	4⅝	5-10½	3-2	2-5¼	3½	1-5	4-4⅝	5-5	10	8-8⅜	0-9⅞	3⅜	3-5	0-9⅜	5-0	3-2	2-⅞	1-7¾

Dimensions are approximate.

NORDBERG MODEL N4HD
FOUR BEARING SCREENS
DOUBLE DECK SPECIFICATIONS

Allow 2 inch clearance around moving unit

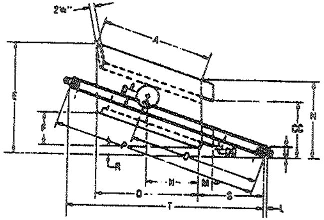


FIGURE I

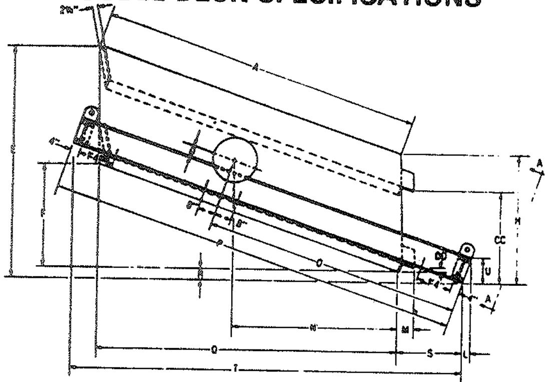
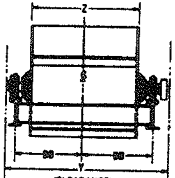


FIGURE II



(CLEARANCE)
VIEW AT "A-A"

SIZE feet	WGT lbs	H.P STROKE ⅛	H.P STROKE ¼	A ft-in	D in	E ft-in	F ft-in	H ft-in	L in	M in	N ft-in	O ft-in	P ft	Q ft-in	R ft-in	S ft-in	T ft-in	U ft-in	Y ft-in	Z ft-in	BB ft-in	CC ft-in	DD in
2x3	900	—	2	3-2½	3¼	4-½	1-1	3-0	1¾	6⅝	1-7⅛	4-7⅝	7	2-11¾	0-4⅜	2-6⅜	6-7	0-4¾	3-3	2-2	1-4¼	2-2½	—
2x4	1000	—	2	4-2½	3¼	4-4⅝	1-5⅛	3-0	1¾	6⅝	2-¾	5-1⅝	8	3-11	0-4⅜	2-6⅜	7-6¼	0-4¾	3-3	2-2	1-4¼	2-2½	—
2x6	2000	—	3	6-2½	4⅝	5-6⅞	2-1¼	3-6	3½	6⅝	3-4¼	6-6⅛	10	5-9½	0-10⅜	2-4⅛	9-4¾	0-9⅜	4-0	2-2	1-6⅞	2-8½	—
2x8	2400	—	5	8-2½	4⅝	6-3	2-9½	3-6	3½	6⅝	4-3½	7-6⅛	12	7-8⅛	0-10⅜	2-4⅛	11-3⅜	0-9⅜	4-0	2-2	1-6⅞	2-8½	—
3x6	2100	—	5	6-2½	4⅝	5-6⅞	2-1¼	3-6	3½	6⅝	3-6⅜	6-8⅜	10	5-9½	0-10⅜	2-4⅛	9-4¾	0-9⅜	5-0	3-2	2-⅞	2-8½	—
3x8	2800	—	5	8-2½	4⅝	6-3	2-9½	3-6	3½	6⅝	4-5⅝	7-7 7/16	12	7-8⅛	0-10⅜	2-4⅛	11-3⅜	0-9⅜	5-0	3-2	2-⅞	2-8½	—
3x10	3100	—	5	10-2½	4⅝	6-11¼	3-5¾	3-6	3½	6⅝	5-1⅞	8-5⅛	14	9-6⅝	0-10⅜	2-4⅛	13-1⅞	0-9⅜	5-0	3-2	2-⅞	2-8½	—

Dimensions are approximate.

NORDBERG MODEL N4HD

FOUR BEARING SCREENS

DOUBLE DECK SPECIFICATIONS (Continued)

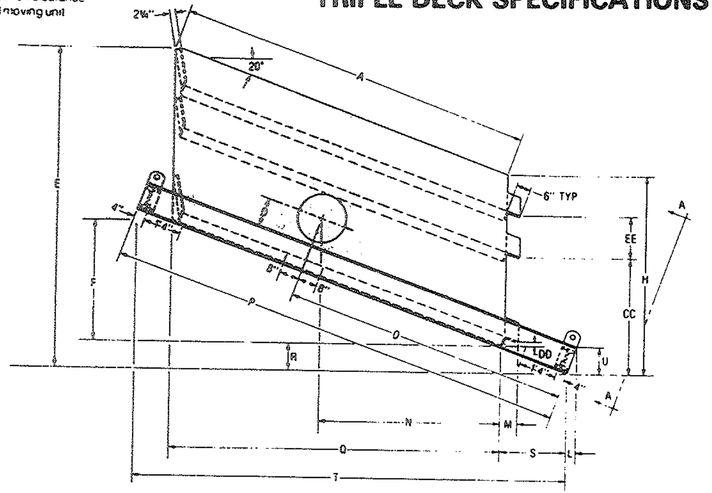
4x8	6200	5	5	8-2 1/2	6 1/2	7-9 11/16	2-9 3/4	5-3/16	4 1/8	7 1/4	4-2 3/8	7-8 1/8	12	7-8 7/8	0-6 7/16	2-5 5/8	11-3 3/8	0-11 1/4	6-3 1/2	4-2	2-8 9/16	3-7 5/16	—
4x10	6800	7.5	5	10-2 1/2	6 1/2	8-5 15/16	3-6	5-3/16	4 1/8	7 1/4	5-4 5/8	8-11 1/4	14	9-7 3/8	0-6 7/16	2-5 5/8	13-1 7/8	0-11 1/4	6-3 1/2	4-2	2-8 9/16	3-7 5/16	—
4x12	7500	7.5	5	12-2 1/2	6 1/2	9-2 1/16	4-2 1/4	5-3/16	4 1/8	7 1/4	6-3 7/8	9-11 1/4	16	11-5 7/8	0-6 7/16	2-5 5/8	15-1/2	0-11 1/4	6-3 1/2	4-2	2-8 9/16	3-7 5/16	—
4x14	8100	7.5	5	14-2 1/2	6 1/2	10-1 3/16	4-10 3/8	5-3 1/16	5 1/8	7 1/4	7-3 1/8	10-11 1/4	18	13-4 1/2	0-9 5/16	2-4 1/2	16-11	1-2 1/8	6-3 1/2	4-2	2-8 9/16	3-10 3/16	—
5x10	8300	10	7.5	10-3 7/8	6 1/2	8-9 3/16	3-5 3/4	5-3 1/16	4 1/8	7 3/4	5-1/8	8-6 1/2	14	9-6 3/4	0-6 5/16	2-5 5/8	13-1 7/8	0-11 1/4	7-3 1/2	5-2	3-2 9/16	3-10 1/16	3 5/8
5x12	9200	10	10	12-3 7/8	6 1/2	9-4 15/16	4-2	5-3 1/16	4 1/8	7 3/4	6-2 3/8	9-9 3/4	16	11-5 3/4	0-6 5/16	2-5 5/8	15-1/2	0-11 1/4	8-11 3/8	5-2	3-2 9/16	3-10 1/16	3 5/8
5x14	10100	15	10	14-3 7/8	6 1/2	10-3 7/8	4-10 1/8	5-5 7/8	5 1/8	7 3/4	7-1 7/8	10-9 3/4	18	13-3 7/8	0-9 1/8	2-2 7/8	16-11	1-2 1/8	8-11	5-2	3-2 9/16	4-7/8	3 5/8
5x16	11500	15	10	16-3 7/8	11 1/2	11-4 3/4	5-6 3/8	5-10 1/2	5 1/8	7 3/4	8-1 1/8	11-9 3/4	20	15-2 3/8	1-1 3/4	2-2 7/8	18-9 1/2	1-2 1/8	8-10	5-2	3-6	4-5 1/2	3 5/8
6x12	10100	15	10	12-3 7/8	6 1/2	9-7 3/4	4-2	5-5 7/8	5 1/8	7 3/4	6-2 3/8	9-9 3/4	16	11-5 1/4	0-9 1/8	2-2 7/8	15-1/2	1-2 1/8	9-5	6-2	3-8 9/16	4-2 [illegible]	3 5/8
6x14	10600	15	10	14-3 7/8	6 1/2	10-3 7/8	4-10 1/8	5-5 7/8	5 1/8	7 3/4	7-1 7/8	10-9 3/4	18	13-3 7/8	0-9 1/8	2-2 7/8	16-11	1-2 1/8	9-5	6-2	3-8 9/16	4-2 [illegible]	3 5/8
6x16	11800	15	15	16-3 7/8	6 1/2	11-1/8	5-6 3/8	5-5 7/8	5 1/8	7 3/4	8-1 1/8	11-9 3/4	20	15-2 3/8	0-9 1/8	2-2 7/8	18-9 1/2	1-2 1/8	9-5	6-2	3-8 9/16	4-2 7/8	3 5/8
6x18	13700	20	15	18-3 7/8	11 1/2	12-1	6-2 5/8	5-10 1/2	5 1/8	7 3/4	9-3/8	12-9 3/4	22	17-1	1-1 3/4	2-2 7/8	20-8 1/8	1-2 1/8	9-10	6-2	4-0	4-5 1/2	3 5/8
6x20	14700	20	15	20-3 7/8	11 1/2	12-9 1/4	6-10 3/4	5-10 1/2	5 1/8	7 3/4	9-11 5/8	13-9 3/4	24	18-11 1/2	1-1 3/4	2-2 7/8	22-6 5/8	1-2 1/8	9-10	6-2	4-0	4-5 1/2	3 5/8
7x14	14800	20	15	14-4 3/4	11 1/2	11-1/2	4-10 1/2	6-1/4	5 1/8	8 3/8	7-2 3/4	11-1/8	18	13-4 3/4	0-9 3/4	2-4 3/8	16-11	1-2 1/8	10-10	7-2	4-6	4-9 1/2	5 1/2
7x16	16100	25	20	16-4 3/4	11 1/2	11-8 3/4	5-6 3/4	6-1/4	5 1/8	8 3/8	8-2 1/8	12-1/8	20	15-3 1/4	0-9 3/4	2-4 1/8	18-9 1/2	1-2 1/8	10-10	7-2	4-6	4-9 1/2	5 1/2
7x18	17300	25	20	18-4 3/4	11 1/2	12-4 7/8	6-2 7/8	6-1/4	5 1/8	8 3/8	9-1 3/8	13-1/8	22	17-1 3/4	0-9 3/4	2-4 3/8	20-8 1/8	1-2 1/8	11-2	7-2	4-6	4-9 1/2	5 1/2
7x20	18500	25	20	20-4 3/4	11 1/2	13-1 1/8	6-11 1/8	6-1/4	5 1/8	8 3/8	10-5/8	14-1/8	24	19-3/8	0-9 3/4	2-4 3/8	22-6 5/8	1-2 1/8	11-2	7-2	4-6	4-9 1/2	5 1/2
8x16	18000	25	20	16-5 3/8	11 1/2	12-5/8	5-6 3/4	6-1/4	5 1/8	8 3/4	8-4 3/4	12-3 1/4	20	15-3 1/4	0-8 7/8	2-4 3/4	18-9 1/2	1-2 1/8	12-2	8-2	5-0	4-10 3/4	6 3/8
8x18	19500	30	25	18-5 3/8	11 1/2	12-8 7/8	6-2 3/4	6-1/4	5 1/8	8 3/4	9-4	13-3 1/4	22	17-1 3/4	0-8 7/8	2-4 3/4	20-8 1/8	1-2 1/8	12-2	8-2	5-0	4-10 3/4	6 3/8
8x20	22000	40	25	20-5 3/8	11 1/2	13-5 3/4	6-11 3/4	6-1/4	5 1/8	8 3/4	10-3 1/4	14-3 1/4	24	19-3/8	0-8 7/8	2-4 5/8	22-6 5/8	1-2 1/8	12-5	8-2	5-3/8	4-10 3/4	6 3/8
8x24	24000	40	30	24-5 3/8	11 1/2	14-9 3/8	8-3 3/4	6-1/4	5 1/8	8 3/4	12-1 3/4	16-3 1/4	28	22-9 1/2	0-8 7/8	2-4 5/8	26-3 3/4	1-2 1/8	12-5	8-2	5-3/8	4-10 3/4	6 3/8

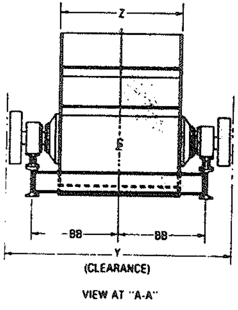
Note: *Fig I configuration applies only to sizes 2 x3 and 2 x4 Fig II configuration applies to all others*

Dimensions are approximate.

NORDBERG MODEL N4HD
FOUR BEARING SCREENS
TRIPLE DECK SPECIFICATIONS

Allow 2 inch clearance around moving unit





SIZE feet	WGT lbs	H. P. STROKE 3/8"	H. P. STROKE 1/2"	A ft.-in.	D in.	E ft.-in.	F ft.-in.	H ft.-in.	L in.	M in.	N ft.-in	O ft.-in	P ft	Q ft.-in	R ft.-in.	S ft.-in	T ft.-in	U ft.-in.	Y ft.-in.	Z ft.-in.	BB ft.-in.	CC ft.-in.	DD in.	EE ft.-in.
2x8	2900	—	5	8-2½	4⅝	7-1⅞	2-9½	4-4¾	3½	6⅝	4-1⅝	7-11¾	12	7-8½	0-5¼	2-6	11-3⅜	0-9⅜	4-0	2-2	1-7	2-3⅜	¾	1-4
3x6	2600	—	5	6-2½	4⅝	6-5⅝	2-1¼	4-4¾	3½	6⅝	3-2⅜	6-11¾	10	5-9½	0-5¼	2-6	9-4¾	0-9⅜	5-0	3-2	2-1	2-3⅜	¾	1-4
3x8	3500	—	5	8-2½	4⅝	7-1⅞	2-9½	4-4¾	3½	6⅝	4-1⅝	7-11¾	12	7-8½	0-5¼	2-6	11-3⅜	0-9⅜	5-0	3-2	2-1	2-3⅜	¾	1-4
3x10	5100	7.5	7.5	10-2½	5¾	7-11⅛	3-5¾	4-5¾	3½	6⅝	5-3¾	9-2¾	14	9-6⅝	0-6¼	2-5⅝	13-1⅞	0-9⅜	5-2	3-2	2-1⅝	2-4⅜	¾	1-4

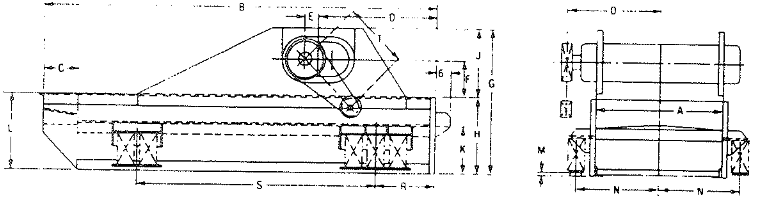
Dimensions are approximate.

NORDBERG MODEL N4HD
FOUR BEARING SCREENS
TRIPLE DECK SPECIFICATIONS (Continued)

4x8	7200	7.5	7.5	8-3 7/8	6 1/2	9-2 11/16	2-9 1/4	6-5 5/16	4 1/8	7 1/4	4-2 1/8	7-7 1/4	12	7-8 7/8	0-6 7/16	2-5 7/8	11-3 3/8	0-11 1/4	6-3 1/2	4-2	2-8 9/16	3-7 5/16	1 3/4	1-5
4x10	8300	10	7.5	10-3 7/8	6 1/2	9-10 15/16	3-6	6-5 3/16	4 1/8	7 1/4	5-4 1/8	8-10 7/8	14	9-7 3/8	0-6 7/16	2-5 7/8	13-1 7/8	0-11 1/4	6-3 1/2	4-2	2-8 9/16	3-7 5/16	1 3/4	1-5
4x12	10300	15	10	12-3 7/8	11 1/2	11-0	4-2 1/4	6-10	4 1/8	7 1/4	6-3 7/8	9-10 5/8	16	11-5 7/8	0-11 1/4	2-3 7/8	15-3/8	0-11 1/4	7-10	4-2	3-0	4-1/8	1 3/4	1-5
4x14	11000	15	10	14-3 7/8	11 1/2	11-10 7/8	4-10 3/8	7-1/4	5 1/8	7 1/4	7-3 1/8	10-10 7/8	18	13-4 1/2	1-2	2-2 7/8	16-11	1-2 1/8	7-10	4-2	3-0	4-2 7/8	1 3/4	1-5
5x10	10500	15	10	10-3 7/8	11 1/2	10-8 5/8	3-5 3/4	7-2 7/8	4 1/8	7 1/4	5-1/4	8-6 1/2	14	9-6 3/4	0-11	2-5 3/4	13-1 7/8	0-11 1/4	8-10	5-2	3-6	4-2 3/4	3 5/8	1-7 1/8
5x12	11500	15	15	12-3 7/8	11 1/2	11-4 3/4	4-2	7-2 7/8	4 1/8	7 1/4	6-2 1/8	9-9 1/4	16	11-5 1/4	0-11	2-5 3/4	15-1/2	0-11 1/4	8-10	5-2	3-6	4-2 3/4	3 5/8	1-7 1/8
5x14	12800	20	15	14-3 7/8	11 1/2	12-3 3/4	4-10 1/8	7-5 5/8	5 1/8	7 1/4	7-1 1/8	10-9 1/4	18	13-3 7/8	1-1 3/4	2-2 7/8	16-11	1-2 1/8	8-10	5-2	3-6	4-5 1/2	3 5/8	1-7 1/8
5x16	13900	20	15	16-3 7/8	11 1/2	13-0	5-6 3/8	7-5 5/8	5 1/8	7 1/4	8-1/8	11-9 1/4	20	15-2 3/8	1-1 3/4	2-2 7/8	18-9 1/2	1-2 1/8	8-10	5-2	3-6	4-5 1/2	3 5/8	1-7 1/8
6x12	12900	15	15	12-3 7/8	11 1/2	11-7 1/2	4-2	7-5 5/8	5 1/8	7 1/4	6-2 1/8	9-9 1/4	16	11-5 1/4	1-1 3/4	2-2 7/8	15-1/2	1-2 1/8	9-10	6-2	4-0	4-5 1/2	3 5/8	1-7 1/8
6x14	13500	20	15	14-3 7/8	11 1/2	12-3 3/4	4-10 1/8	7-5 5/8	5 1/8	7 3/4	7-1 1/8	10-9 1/4	18	13-3 7/8	1-1 3/4	2-2 7/8	16-11	1-2 1/8	9-10	6-2	4-0	4-5 1/2	3 5/8	1-7 1/8
6x16	15200	25	20	16-3 7/8	11 1/2	13-0	5-6 3/8	7-5 5/8	5 1/8	7 3/4	8-1/8	11-9 1/4	20	15-2 1/8	1-1 3/4	2-2 7/8	18-9 1/2	1-2 1/8	9-10	6-2	4-0	4-5 1/2	3 5/8	1-7 1/8
6x18	16800	25	20	18-3 7/8	11 1/2	13-8 1/4	6-2 3/8	7-5 5/8	5 1/8	7 3/4	8-11 7/8	12-9 1/4	22	17-1	1-1 3/4	2-2 7/8	20-8 1/8	1-2 1/8	9-10	6-2	4-0	4-5 1/2	3 5/8	1-7 1/8
6x20	19200	30	20	20-3 7/8	11 1/2	14-4 3/4	6-10 3/4	7-5 5/8	5 1/8	7 3/4	9-11 1/8	13-9 1/4	24	18-11 1/2	1-1 3/4	2-2 7/8	22-6 5/8	1-2 1/8	10-2	6-2	4-3/8	4-5 1/2	3 5/8	1-7 1/8
7x14	18800	30	20	14-4 3/4	11 1/2	12-9 3/4	4-10 1/2	7-9 1/2	5 1/8	8 3/8	7-2 1/4	10-11 5/8	18	13-4 3/4	0-9 3/4	2-4 3/8	16-11	1-2 1/8	11-2	7-2	4-6	4-9 1/4	5 1/2	1-9 1/4
7x16	20900	30	25	16-4 3/4	11 1/2	13-6	5-6 3/4	7-9 1/2	5 1/8	8 3/8	8-1 1/2	11-11 5/8	20	15-3 1/4	0-9 3/4	2-4 3/8	18-9 1/2	1-2 1/8	11-2	7-2	4-6 3/8	4-9 1/4	5 1/2	1-9 1/4
7x18	24300	40	30	18-4 3/4	11 1/2	14-2 1/8	6-2 7/8	7-9 1/2	5 1/8	8 3/8	9-3/4	12-11 5/8	22	17-1 3/4	0-9 3/4	2-4 3/8	20-8 1/8	1-2 1/8	11-2	7-2	4-7 1/8	4-9 1/4	5 1/2	1-9 1/4
7x20	26300	40	30	20-4 3/4	11 1/2	14-10 3/8	6-11 1/8	7-9 1/2	5 1/8	8 3/8	10-0	13-11 5/8	24	19-3/8	0-9 3/4	2-4 3/8	22-6 5/8	1-2 1/8	11-2	7-2	4-7 1/8	4-9 1/4	5 1/2	1-9 1/4
8x16	25700	40	30	16-5 3/8	11 3/4	13-11 1/8	5-6 3/4	8-2 1/2	5 1/8	8 3/4	8-4 1/4	12-3 1/2	20	15-3 1/4	0-9 1/8	2-4 5/8	18-9 1/2	1-2 1/8	12-5	8-2	5-1 1/8	4-10 1/2	6 3/8	1-10 3/8
8x18	27600	40	40	18-5 3/8	11 3/4	14-7 1/4	6-2 7/8	8-2 1/2	5 1/8	8 3/4	9-4	13-3 1/2	22	17-1 3/4	0-9 1/8	2-4 5/8	20-8 1/8	1-2 1/8	12-5	8-2	5-1 1/8	4-10 1/2	6 3/8	1-10 3/8
8x20	30200	50	40	20-5 3/8	11 3/4	15-3 1/2	6-11 1/8	8-2 1/2	5 1/8	8 3/4	10-3 1/4	14-3 1/2	24	19-3/8	0-9 1/8	2-4 5/8	22-6 5/8	1-2 1/8	12-5	8-2	5-1 1/8	4-10 1/2	6 3/8	1-10 3/8
8x24	32800	60	50	24-5 3/8	11 3/4	16-7 7/8	8-3 1/2	8-2 1/2	5 1/8	8 3/4	12-1 3/4	16-3 1/2	28	22-9 1/2	0-9 1/8	2-4 5/8	26-2 3/4	1-2 1/8	12-5	8-2	5-1 1/8	4-10 1/2	6 3/8	1-10 3/8

Dimensions are approximate.

NORDBERG MODEL NHZ
HORIZONTAL SCREENS
SINGLE DECK SPECIFICATIONS



SIZE feet	WGT lbs	HP NEMA (Type) C	HP NEMA (Type) B	A ft-in	B ft-in	C ft-in	D ft-in	E in	F ft-in	G ft-in	H ft-in	J ft-in	K ft-in	L ft-in	M in	N ft-in	O ft-in	R ft-in	S ft-in	T ft-in
4x8	6500	15	15	4-2	9-2	1-2	2-3/4	5 1/2	1-2 5/8	4-6 5/8	2-3 1/4	2-3 3/8	1-6	2-3	1 5/8	2-10 1/2	2-11 7/16	2-0	4-0	1-10
4x10	6800	15	15	4-2	11-2	1-2	3-3/4	5 1/2	1-2 5/8	4-6 5/8	2-3 1/4	2-3 3/8	1-6	2-3	1 11/16	2-10 1/2	2-11 7/16	2-0	6-0	1-10
4x12	7200	15	20	4-2	13-2	1-2	4-1/2	5 1/2	1-2 5/8	4-6 5/8	2-3 1/4	2-3 3/8	1-6	2-3	1 3/4	2-10 1/2	2-11 7/16	2-0	8-0	1-10
4x14	8600	15	20	4-2	15-2	1-2	5-5/8	5 1/2	1-2 5/8	4-6 5/8	2-3 1/4	2-3 3/8	1-6	2-3	1 13/16	2-10 1/2	2-11 7/16	2-0	10-0	1-10
4x16	9000	15	20	4-2	17-2	1-2	6-5/8	5 1/2	1-2 5/8	4-6 5/8	2-3 1/4	2-3 3/8	1-6	2-3	1 7/8	2-10 1/2	2-11 7/16	1-6	13-6	1-10
5x10	7800	15	20	5-2	11-2	1-2	2-9 13/16	5 1/2	1-2 5/8	4-9 5/8	2-6 1/4	2-3 3/8	1-9	2-6	1 7/8	3-4 9/16	3-5 7/16	2-0	6-0	1-10
5x12	8200	20	25	5-2	13-2	1-2	3-10 1/2	5 1/2	1-2 5/8	4-9 5/8	2-6 1/4	2-3 3/8	1-9	2-6	2	3-4 9/16	3-5 7/16	2-0	8-0	1-10
5x14	8600	20	25	5-2	15-2	1-2	4-10 1/2	5 1/2	1-2 5/8	4-9 5/8	2-6 1/4	2-3 3/8	1-9	2-6	2	3-4 9/16	3-5 7/16	2-0	10-0	1-10
5x16	10600	25	30	5-2	17-2	1-2	5-10 3/8	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 5/16	3-4 9/16	3-3 1/8	1-6	13-6	1-11 5/8
5x18	11100	20	30	5-2	19-2	1-2	6-10 3/8	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 7/16	3-4 9/16	3-3 1/8	1-6	15-6	1-11 5/8
5x20	11800	25	30	5-2	21-2	1-2	7-10 3/8	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 3/8	3-4 9/16	3-3 1/8	2-6	14-6	1-11 5/8

Dimensions are approximate.

NORDBERG MODEL NHZ
HORIZONTAL SCREENS
SINGLE DECK SPECIFICATIONS (Continued)

6x12	11200	25	30	6-2	13-2	1-2	3-10 3/16	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 7/8	3-10 5/8	3-9 1/8	2-0	8-0	1-11 5/8
6x14	11700	25	30	6-2	15-2	1-2	4-10 3/16	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 1/4	3-10 5/8	3-9 1/8	2-0	10-0	1-11 5/8
6x16	12800	25	40	6-2	17-2	1-2	5-10 1/8	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 1/4	3-10 5/8	3-9 1/8	1-6	13-6	1-11 5/8
6x18	13300	25	40	6-2	19-2	1-2	6-10 1/8	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 3/8	3-10 5/8	3-9 1/8	1-6	15-6	1-11 5/8
6x20	14000	30	40	6-2	21-2	1-2	7-10 1/8	6 5/8	1-2 3/4	4-8 1/2	2-6 1/4	2-2 1/4	1-9	2-6	2 1/2	3-10 5/8	3-9 1/8	2-6	14-6	1-11 5/8
7x14	13400	30	40	7-2	15-6	1-6	4-9 3/4	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	2 1/2	4-4 5/8	4-3 1/8	2-0	10-0	1-11 5/8
7x16	14500	30	40	7-2	17-6	1-6	5-9 7/8	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	2 9/16	4-4 5/8	4-3 1/8	1-6	13-6	1-11 5/8
7x18	15000	30	50	7-2	19-6	1-6	6-10	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	2 5/8	4-4 5/8	4-3 1/8	1-6	15-6	1-11 5/8
7x20	15600	40	50	7-2	21-6	1-6	7-10 1/8	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	2 1/2	4-4 5/8	4-3 1/8	2-6	14-6	1-11 5/8
8x16	16200	40	50	8-2	17-6	1-6	5-8 3/4	6 5/8	1-2 3/4	4-11 1/2	2-9 1/4	2-2 1/4	2-0	2-9	2 1/4	4-10 5/8	4-9 1/8	1-6	13-6	1-11 5/8
8x18	16900	40	50	8-2	19-6	1-6	6-8 7/8	6 5/8	1-2 3/4	4-11 1/2	2-9 1/4	2-2 1/4	2-0	2-9	2 1/4	4-10 5/8	4-9 1/8	1-6	15-6	1-11 5/8
8x20	17800	40	60	8-2	21-6	1-6	7-8 7/8	6 5/8	1-2 3/4	4-11 1/2	2-9 1/4	2-2 1/4	2-0	2-9	2 3/8	4-10 5/8	4-9 1/8	2-6	14-6	1-11 5/8
8x22	19100	40	75	8-2	23-6	1-6	8-7 1/4	7	1-4	5-2 3/4	2-9 1/4	2-4	2-0	2-9	4 3/4	4-10 5/8	4-11	3-6	14-6	2-7 1/4
8x24	20100	50	75	8-2	25-6	1-6	10-5	7	1-4	5-2 3/4	2-10 3/4	2-4	2-0	2-10 3/4	4 3/4	4-10 5/8	4-11	3-6	16-6	2-7 1/4

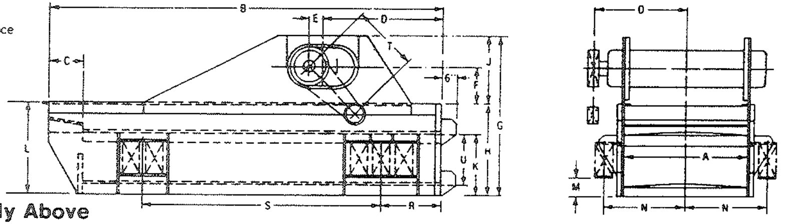
Dimensions are approximate.

NORDBERG MODEL NHZ

HORIZONTAL SCREENS

DOUBLE DECK SPECIFICATIONS

Allow 2 inch clearance around moving unit



Assembly Above

SIZE feet	WGT lbs	HP NEMA C	P (Type) B	A ft-in	B ft-in	C ft-in	D ft-in	E in	F ft-in	G ft-in	H ft-in	J ft-in	K ft-in	L ft-in	M in.	N ft-in	O ft-in	R ft-in.	S ft-in	T ft-in.	U ft-in
4x8	7000	15	20	4-2	9-2	1-2	1-9 3/4	5 1/2	1-2 5/8	4-11 5/8	2-8 1/4	2-3 3/8	1-11	2-8	6 3/4	2-10 1/2	2-11 7/16	2-0	4-0	1-10	1-7
4x10	8700	15	20	4-2	11-2	1-2	2-7 3/8	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	6 15/16	2-10 1/2	2-9 1/8	2-0	6-0	1-11 5/8	1-7
4x12	9300	20	25	4-2	13-2	1-2	3-7 3/8	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	7 1/16	2-10 1/2	2-9 1/8	2-0	8-0	1-11 5/8	1-7
4x14	10000	20	25	4-2	15-2	1-2	4-7 1/2	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	7 3/16	2-10 1/2	2-9 1/8	2-0	10-0	1-11 5/8	1-7
4x16	10700	20	25	4-2	17-2	1-2	5-7 1/2	6 5/8	1-2 3/4	4-10 1/2	2-8 1/4	2-2 1/4	1-11	2-8	7 3/16	2-10 1/2	2-9 1/8	2-0	12-0	1-11 5/8	1-7
5x10	7800	15	20	5-2	11-2	1-2	2-4 1/8	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 5/16	3-4 9/16	3-3 1/8	2-0	6-0	1-11 5/8	1-10
5x12	11100	20	30	5-2	13-2	1-2	3-4 3/8	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 7/16	3-4 9/16	3-3 1/8	2-0	8-0	1-11 5/8	1-10
5x14	11700	25	30	5-2	15-2	1-2	4-4 3/8	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 5/16	3-4 9/16	3-3 1/8	2-0	10-0	1-11 5/8	1-10
5x16	12600	25	40	5-2	17-2	1-2	5-4 1/2	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 3/8	3-4 9/16	3-3 1/8	2-0	12-0	1-11 5/8	1-10
5x18	13200	25	40	5-2	19-2	1-2	6-4 1/2	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 1/2	3-4 9/16	3-3 1/8	2-6	12-6	1-11 5/8	1-10
5x20	13900	30	40	5-2	21-2	1-2	7-4 9/16	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 1/2	3-4 9/16	3-3 1/8	2-6	14-6	1-11 5/8	1-10
6x12	13400	25	40	6-2	13-2	1-2	3-5 3/8	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 7/16	3-10 5/8	3-9 1/8	2-0	8-0	1-11 5/8	1-10
6x14	14200	25	40	6-2	15-2	1-2	4-5 7/16	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 1/2	3-10 5/8	3-9 1/8	2-0	10-0	1-11 5/8	1-10
6x16	15000	30	40	6-2	17-2	1-2	5-5 1/2	6 5/8	1-2 3/4	5-3 1/2	3-1 1/4	2-2 1/4	2-4	3-1	9 9/16	3-10 5/8	3-9 1/8	1-6	12-6	1-11 5/8	1-10
6x18	16200	30	40	6-2	19-2	1-2	6-4 1/4	7	1-4	5-6 3/4	3-1 1/4	2-4	2-4	3-1	9 3/8	3-10 5/8	3-11	2-6	12-6	2-7 1/4	1-10
5x20	16900	40	50	6-2	21-2	1-2	7-4 3/8	7	1-4	5-6 3/4	3-1 1/4	2-4	2-4	3-1	9 7/16	3-10 5/8	3-11	2-6	14-6	2-7 1/4	1-10

Dimensions are approximate.

NORDBERG MODEL NHZ

HORIZONTAL SCREENS

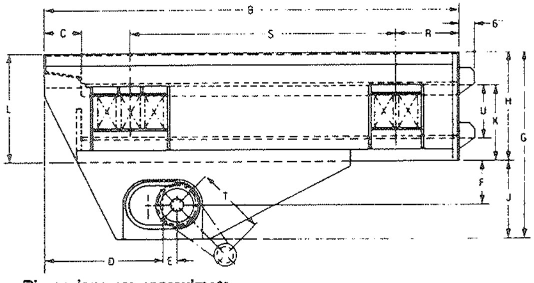
DOUBLE DECK SPECIFICATIONS (Continued)

7x14	16200	40	50	7-2	15-6	1-6	4-4¼	6⅝	1-2¾	5-7½	3-5¼	2-2¼	2-8	3-5	4½	4-4⅝	4-3⅛	2-0	10-0	1-11⅝	2-0
7x16	17100	40	50	7-2	17-6	1-6	5-3⅛	6⅝	1-2¾	5-7½	3-5¼	2-2¼	2-8	3-5	6⅝	4-4⅝	4-3⅛	1-6	12-6	1-11⅝	2-0
7x18	18600	40	60	7-2	19-6	1-6	6-1⅞	7	1-4	5-9¼	3-5¼	2-4	2-8	3-5	6 13/16	4-4⅝	4-5	2-6	12-6	2-7¼	2-0
7x20	19500	40	60	7-2	21-6	1-6	7-2½	7	1-4	5-9¼	3-5¼	2-4	2-8	3-5	6 15/16	4-4⅝	4-5	2-6	14-6	2-7¼	2-0
8x16	19800	40	75	8-2	17-6	1-6	5-1 1/16	7	1-4	6-¾	3-8¾	2-4	2-10	3-8¾	5	4-10⅝	4-11	1-6	12-6	2-7¼	2-1
8x18	21200	50	75	8-2	19-6	1-6	6-1⅛	7	1-4	6-¾	3-8¾	2-4	2-10	3-8¾	5⅛	4-10⅝	4-11	2-6	12-6	2-7¼	2-1
8x20	22500	50	75	8-2	21-6	1-6	7-1⅛	7	1-4	6-¾	3-8¾	2-4	2-10	3-8¾	5⅛	4-10⅝	4-11	2-6	14-6	2-7¼	2-1
8x22	26500	60	100	8-2	23-6	1-6	7-6⅛	8	1-11	6-10¾	3-8¾	3-2	2-10	3-8¾	5 5/16	4-10⅝	4-11¼	3-6	14-6	2-7¼	2-1
8x24	28500	60	100	8-2	25-6	1-6	8-6¼	8	1-11	6-10¾	3-8¾	3-2	2-10	3-8¾	5⅜	4-10⅝	4-11¼	3-6	16-6	2-7¼	2-1

Assembly Below

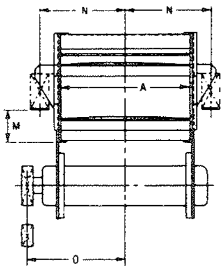
SIZE feet	WGT lbs	H P NEMA C	H P (Type) B	A ft-in	B ft-in	C ft-in	D ft-in	E in	F ft-in	G ft-in	H ft-in	J ft-in	K ft-in	L ft-in	M ft-in	N ft-in	O ft-in	R ft-in	S ft-in		U ft-in
4x14	10000	20	25	4-2	15-2	1-2	5-1½	6⅝	1-2¾	5-2	2-11¾	2-2¼	2-2½	2-11½	10 11/16	2-10½	2-9⅛	2-0	10-6		1-7
5x16	12600	25	40	5-2	17-2	1-2	5-11	6⅝	1-2¾	5-8	3-5¾	2-2¼	2-8½	3-5½	1-2	3-4 9/16	3-3⅛	2-0	12-6		1-10
6x16	15000	30	40	6-2	17-2	1-2	5-11	6⅝	1-2¾	5-8	3-5¾	2-2¼	2-8½	3-5½	1-2⅛	3-10⅝	3-9⅛	2-0	12-6		1-10

Allow 2 inch clearance around moving unit



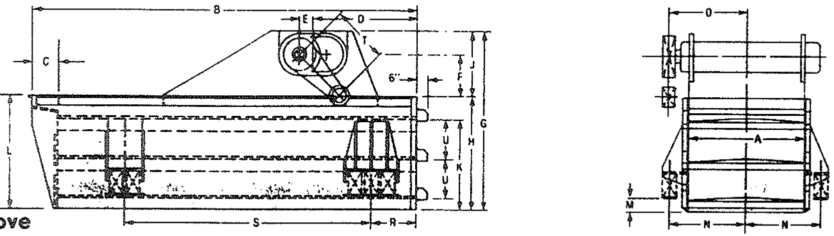
Dimensions are approximate.

Dimensions are approximate.



NORDBERG MODEL NHZ
HORIZONTAL SCREENS
TRIPLE DECK SPECIFICATIONS

Allow 2 inch clearance around moving unit



Assembly Above

SIZE feet	WGT lbs	H. P. NEMA (Type) C	H. P. NEMA (Type) B	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E in.	F ft.-in.	G ft.-in.	H ft.-in.	J ft.-in.	K ft.-in.	L ft.-in.	M in.	N ft.-in.	O ft.-in.	R ft.-in.	S ft.-in.	T ft.-in.	U ft.-in.
4x12	10600	20	30	4-2	13-2	1-2	2-8 7/8	6 5/8	1-2 3/4	6-5 1/2	4-3 1/4	2-2 1/4	3-6	4-3	7 1/4	2-10 1/2	2-9 1/8	2-0	8-0	1-11 5/8	1-7
4x14	11600	20	30	4-2	15-2	1-2	3-9	6 5/8	1-2 3/4	6-5 1/2	4-3 1/4	2-2 1/4	3-6	4-3	7 3/8	2-10 1/2	2-9 1/8	2-0	10-0	1-11 5/8	1-7
4x16	12500	25	30	4-2	17-2	1-2	4-9	6 5/8	1-2 3/4	6-5 1/2	4-3 1/4	2-2 1/4	3-6	4-3	7 1/2	2-10 1/2	2-9 1/8	2-0	12-0	1-11 5/8	1-7
5x12	13100	25	40	5-2	13-2	1-2	2-4 1/2	6 5/8	1-2 3/4	7-1 1/2	4-11 1/4	2-2 1/4	4-2	4-11	9 1/2	3-4 9/16	3-3 1/8	2-0	8-0	1-11 5/8	1-10
5x14	14000	30	40	5-2	15-2	1-2	3-5	6 5/8	1-2 3/4	7-1 1/2	4-11 1/4	2-2 1/4	4-2	4-11	9 5/8	3-4 9/16	3-3 1/8	2-0	10-0	1-11 5/8	1-10
5x16	15300	30	50	5-2	17-2	1-2	4-3 3/4	7	1-4	7-4 3/4	4-11 1/4	2-4	4-2	4-11	9 3/4	3-4 9/16	3-5	2-0	12-0	2-7 1/4	1-10
5x18	16200	40	50	5-2	19-2	1-2	5-3 3/4	7	1-4	7-4 3/4	4-11 1/4	2-4	4-2	4-11	9 13/16	3-4 9/16	3-5	1-6	3-6	2-7 1/4	1-10
5x20	17100	40	50	5-2	21-2	1-2	6-3 3/4	7	1-4	7-4 3/4	4-11 1/4	2-4	4-2	4-11	9 7/8	3-4 9/16	3-5	2-6	4-6	2-7 1/4	1-10
6x12	16100	30	40	6-2	13-2	1-2	2-4 1/4	7	1-4	7-4 3/4	4-11 1/4	2-4	4-2	4-11	9 1/2	3-10 5/8	3-11	2-0	8-0	2-7 1/4	1-10
6x14	17300	40	50	6-2	15-2	1-2	3-3 1/4	7	1-4	7-4 3/4	4-11 1/4	2-4	4-2	4-11	9 5/8	3-10 5/8	3-11	2-0	10-0	2-7 1/4	1-10
6x16	18400	40	50	6-2	17-2	1-2	4-3 3/4	7	1-4	7-4 3/4	4-11 1/4	2-4	4-2	4-11	9 1/4	3-10 5/8	3-11	1-6	12-6	2-7 1/2	1-10
6x18	19500	40	50	6-2	19-2	1-2	5-4 1/4	7	1-4	7-4 3/4	4-11 1/4	2-4	4-2	4-11	2 1/8	3-10 5/8	3-11	1-6	13-6	2-7 1/4	1-10
6x20	20800	40	60	6-2	21-2	1-2	5-9	8	1-11	8-2 3/4	5-3/8	3-2	4-2	5-3/4	2 3/8	3-10 5/8	3-11 1/4	2-6	14-6	2-7 1/4	1-10

Dimensions are approximate.

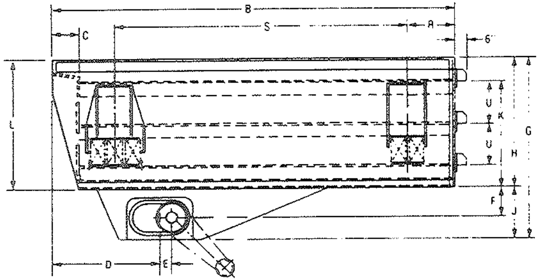
NORDBERG MODEL NHZ
HORIZONTAL SCREENS
TRIPLE DECK SPECIFICATIONS (Continued)

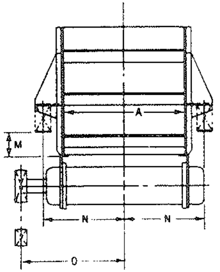
7x14	20000	40	75	7-2	15-6	1-6	3-2¾	7	1-4	7-10¾	5-6¾	2-4	4-8	5-6½	4⅞	4-4⅝	4-5	2-0	10-0	2-7¼	2-0
7x16	21400	50	75	7-2	17-6	1-6	4-2	7	1-4	7-10¾	5-6¾	2-4	4-8	5-6¾	5	4-4⅝	4-5	1-6	12-6	2-7¼	2-0
7x18	26100	60	100	7-2	19-6	1-6	4-7	8	1-11	8-8¾	5-6¾	3-2	4-8	5-6¾	4½	4-4⅝	4-5¼	1-6	13-6	2-7¼	2-0
7x20	26400	60	100	7-2	21-6	1-6	5-7	8	1-11	8-8¾	5-6¾	3-2	4-8	5-6¾	4½	4-4⅝	4-5¼	2-6	14-6	2-7¼	2-0
8x16	16200	30	50	8-2	17-6	1-6	3-5	8	1-11	8-11¾	5-9¾	3-2	4-11	5-9¾	5⅜	4-10⅝	4-11¼	1-6	12-6	2-7¼	2-1
8x18	29400	60	100	8-2	19-6	1-6	4-5	8	1-11	8-11¾	5-9¾	3-2	4-11	5-9¾	5½	4-10⅝	4-11¼	1-6	13-6	2-7¼	2-1
8x20	31400	75	100	8-2	21-6	1-6	5-5	8	1-11	8-11¾	5-9¾	3-2	4-11	5-9¾	5½	4-10⅝	4-11¼	2-6	14-6	2-7¼	2-1
8x22	33400	75	125	8-2	23-6	1-6	6-5	8	1-11	8-11¾	5-9¾	3-2	4-11	5-9¾	5⅝	4-10⅝	4-11¼	3-6	14-6	2-7¼	2-1
8x24	35300	75	125	8-2	25-6	1-6	7-5	8	1-11	8-11¾	5-9¾	3-2	4-11	5-9¾	5¾	4-10⅝	4-11¼	3-6	16-6	2-7¼	2-1

Assembly Below

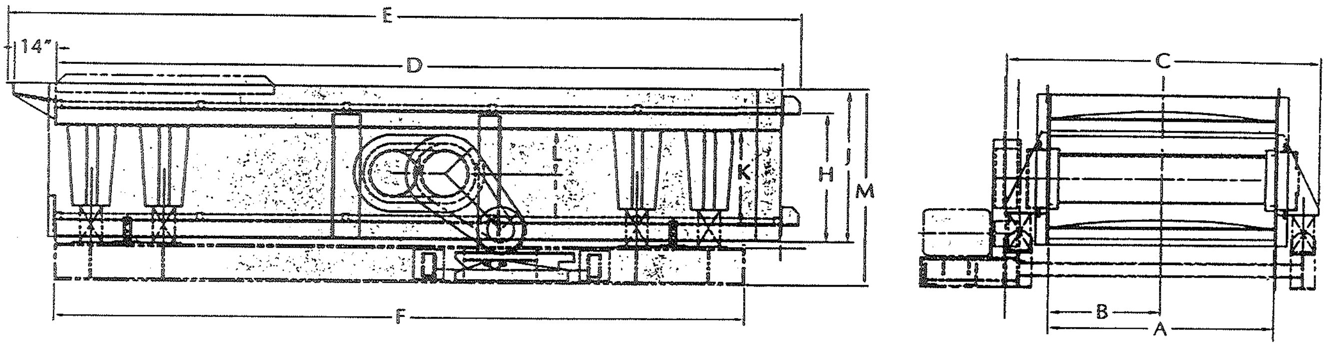
SIZE feet	WGT lbs	H. P. NEMA (Type) C	H. P. NEMA (Type) B	A ft.-in	B ft.-in.	C ft.-in	D ft.-in	E in	F ft.-in	G ft.-in	H ft.-in	J ft.-in	K ft.-in	L ft.-in	M ft.-in	N ft.-in	O ft.-in.	R ft.-in	S ft.-in		U ft.-in.
4x14	11600	20	30	4-2	15-2	1-2	4-4¾	6⅝	1-2¾	6-9	4-6¾	2-2¼	3-9½	4-6½	0-11	2-10½	2-9⅛	2-0	8-6		1-7
5x16	15300	30	50	5-2	17-2	1-2	4-11⅛	7	1-4	7-7¾	5-3¾	2-4	4-6½	5-3½	1-2¼	3-4 9/16	3-5	2-0	12-6		1-10
6x16	18400	40	50	6-2	17-2	1-2	4-10⅝	7	1-4	7-7¾	5-3¾	2-4	4-6½	5-3½	1-2	3-10⅝	3-5	2-0	12-6		1-10

Dimensions are approximate.





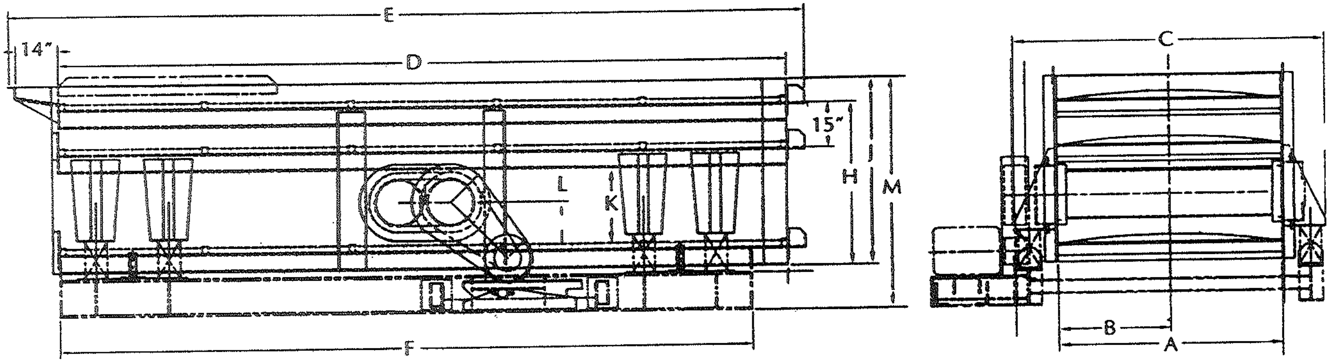
NORDBERG MODEL NHZ
LOW PROFILE HORIZONTAL SCREENS
DOUBLE DECK SPECIFICATIONS



SIZE feet	MECH.	APPX. WT., lbs.	H.P.*	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E ft.-in.	F ft.-in.	G ft.-in.	H ft.-in.	J ft.-in.	K ft.-in.	L ft.-in.	M ft.-in.
5×14	LP140A	13,630	30	5-2	2-7	7-7⅛	14-0	15-10 5/16	13-0	3-4⅝	3-7	4-3	2-7	1-3	5-7 5/16
5×16	LP140A	13,930	30	5-2	2-7	7-7⅛	16-0	17-10 5/16	15-0	3-4⅝	3-7	4-3	2-7	1-3	5-7 5/16
6×16	LP140A	15,480	30	6-2	3-1	8-7⅛	16-0	17-10 5/16	15-0	3-10⅝	3-7	4-3	2-7	1-3	5-7 5/16
6×20	LP140A	17,080	40	6-2	3-1	8-7⅛	20-0	21-10 5/16	19-0	3-10⅝	3-7	4-3	2-7	1-3	5-7 5/16

Dimensions are approximate.

NORDBERG MODEL NHZ
LOW PROFILE HORIZONTAL SCREENS
TRIPLE DECK SPECIFICATIONS



SIZE feet	MECH.	APPX. WT., lbs.	H.P.*	A ft.-in.	B ft.-in.	C ft.-in.	D ft.-in.	E ft.-in.	F ft.-in.	G ft.-in.	H ft.-in.	J ft.-in.	K ft.-in.	L in.	M ft.-in.
5×14	LP140A	15,530	30	5-2	2-7	7-7⅛	14-0	15-10$^{5}/_{16}$	13-0	3-4⅝	4-6	5-2	2-3	11	6-6$^{5}/_{16}$
5×16	LP140A	16,230	30	5-2	2-7	7-7⅛	16-0	17-10$^{5}/_{16}$	15-0	3-4⅝	4-6	5-2	2-3	11	6-6$^{5}/_{16}$
6×16	LP140A	18,280	40	6-2	3-1	8-7⅛	16-0	17-10$^{5}/_{16}$	15-0	3-10⅝	4-6	5-2	2-3	11	6-6$^{5}/_{16}$
6×20	LP140A	20,580	40	6-2	3-1	8-7⅛	20-0	21-10$^{5}/_{16}$	19-0	3-10⅝	4-6	5-2	2-3	11	6-6$^{5}/_{16}$

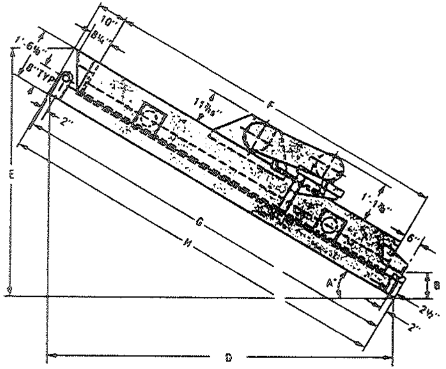
*1800 RPM, NEMA C motor

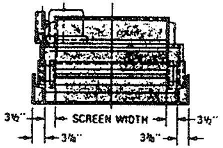
Dimensions are approximate.

NORDBERG MODEL N2HF

TWO BEARING HIGH SPEED
SINGLE DECK SPECIFICATIONS

Allow 2 inch clearance around moving unit.





- Two-bearing gyrating design
- TEFC electric motor, 230/460 volt, 60 cycle, 1800 or 3600 rpm
- Sliding motor base
- Simple stroke adjustment

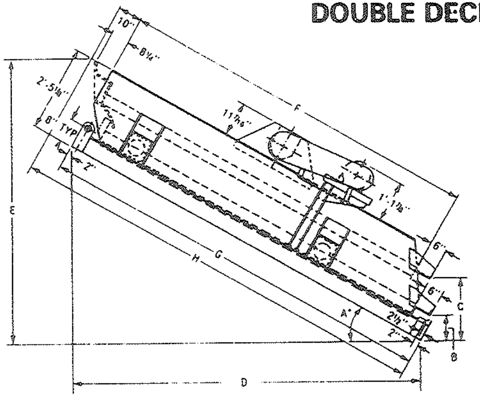
Single Deck

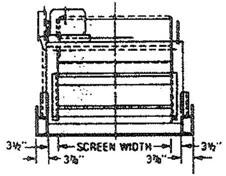
SIZE feet	H.P.	WGT lbs	B A° = 20	B A° = 25	B A° = 30	D A° = 20	D A° = 25	D A° = 30	E A° = 20	E A° = 25	E A° = 30	F ft.-in.	G ft.-in.	H ft.-in.
3×6	3	1500	9 1/16	8 15/16	8 5/8	6-11 5/8	6-8 11/16	6-5 1/16	3-11 5/8	4-6 1/4	5-7/16	6-0	7-5	7-5 1/2
3×8	3	1700	9 1/16	8 15/16	8 5/8	8-10 9/16	8-6 7/16	8-1 7/8	4-7 7/8	5-4 3/8	6-7/16	8-0	9-5	9-5 1/2
3×10	3	1900	9 1/16	8 15/16	8 5/8	10-8 3/4	10-4 3/16	9-10 5/8	5-4 1/16	6-2 1/2	7-7/16	10-0	11-5	11-5 1/2
4×6	3	1700	9 1/16	8 15/16	8 5/8	6-11 5/8	6-8 11/16	6-5 1/16	3-11 5/8	4-6 1/4	5-7/16	6-0	7-5	7-5 1/2
4×8	3	1900	9 1/16	8 15/16	8 5/8	8-10 9/16	8-6 7/16	8-1 7/8	4-7 7/8	5-4 3/8	6-7/16	8-0	9-5	9-5 1/2
4×10	3	2100	9 1/16	8 15/16	8 5/8	10-8 3/4	10-4 3/16	9-10 5/8	5-4 1/16	6-2 1/2	7-7/16	10-0	11-5	11-5 1/2
5×10	5	2600	9 1/16	8 3/4	8 5/8	10-8 3/4	10-4 1/4	9-10 5/8	5-6 7/8	6-6	7-4 1/4	10-0	11-5	11-5 1/2

Dimensions are approximate.

NORDBERG MODEL N2HF
TWO BEARING HIGH SPEED SCREENS
DOUBLE DECK SPECIFICATIONS

- Self-contained oil-in-housing lubrication
- Rugged main frame
- One-piece welded deck
- Unit may be inclined 10 to 40 degrees





Double Deck

SIZE feet	H.P.	WGT lbs	B A° = 20	B A° = 25	B A° = 30	C A° = 20	C A° = 25	C A° = 30	D A° = 20	D A° = 25	D A° = 30	E A° = 20	E A° = 25	E A° = 30	F ft.-in.	G ft.-in.	H ft.-in.
3×6	3	1900	9/16	8 15/16	8 5/8	1-9 7/16	1-9 3/8	1-9 1/8	6-9 3/4	6-6 7/8	6-3 3/8	5-1/16	5-6 3/4	6-1	6-0	7-3	7-11 1/2
3×8	3	2200	9/16	8 15/16	8 5/8	1-9 7/16	1-9 3/8	1-9 1/8	8-8 5/16	8-4 5/8	8-1/8	5-8 1/4	6-4 7/8	7-1	8-0	9-3	9-11 1/2
3×10	3	2500	9/16	8 15/16	8 5/8	1-9 7/16	1-9 3/8	1-9 1/8	10-6 7/8	10-2 3/8	9-8 15/16	6-4 7/16	7-3	8-1	10-0	11-3	11-11 1/2
4×6	3	2200	9/16	8 15/16	8 5/8	1-9 7/16	1-9 3/8	1-9 1/8	6-9 3/4	6-6 7/8	6-3 3/8	5-1/16	5-6 3/4	6-1	6-0	7-3	7-11 1/2
4×8	3	2500	9/16	8 15/16	8 5/8	1-9 7/16	1-9 3/8	1-9 3/8	8-8 15/16	8-4 5/8	8-1/8	5-8 1/4	6-4 7/8	7-1	8-0	9-3	9-11 1/2
4×10	3	2700	9-1/16	8 15/16	8 5/8	1-9 7/16	1-9 3/8	1-9 1/8	10-6 7/8	10-2 3/8	9-8 15/16	6-4 7/16	7-3	8-1	10-0	11-3	11-11 1/2
5×10	5	3300	9/16	8 3/4	8 5/8	1-9 1/2	1-9 3/4	1-7 7/8	10-6 7/8	10-2 3/8	9-9	6-7 1/4	7-6 3/8	8-4 3/4	10-0	11-3	12-6 1/4

Dimensions are approximate.

SYMONS

V-Screen Capacity Data

V-Screen Capacity Data
The V-Screen is manufactured in one size only so a capacity formula is not used. Instead the capacity table based on field experience with various types of materials was established for one V-Screen.

Maximum feed size should be kept in line with the opening in the screen surface. For example separating at 20 mesh (.032" space) a top-size of about 3/16" is considered practical. As a guide it is desirable to keep maximum feed size to a ratio of not more than 5 to 6 times the opening used in the separation. The top-size and amount of same in the feed will have a definite bearing on cloth life. Below is a table listing recommended wire diameters for various screen cloth openings used on the SYMONS V-Screen.

NOTE: The MAXIMUM size piece fed to the V-Screen should be limited to about 1-1/2".

Size Separation U.S. Std. Sieve	Size (Inches)	Size (Microns)	STPH Feed to (1) V-Screen
3	0.2500	6350	75-85
4	0.1870	4760	75-85
8	0.0937	2380	70-80
10	0.0787	2000	60-70
12	0.0661	1680	50-60
14	0.0555	1410	45-55
18	0.0394	1000	35-40
20	0.0331	840	30-35

The V-Screen capacity chart is based on material being relatively dry and weighing about 100 lbs. per cubic foot. It is also based on a split of about 50% oversize and 25% half the size of the opening.

For materials weighing less than 100 lbs. per cubic foot reduce the T.P.H. of feed on the capacity chart accordingly.

When the proportion of oversize and undersize is not 50% and the half size varies above or below 25% V-Screen capacity can be affected. Again feed rates listed in the chart should be adjusted accordingly.

RECOMMENDED WIRE DIAMETER FOR VARIOUS OPENINGS FOR WOVEN WIRE SCREEN CLOTH FOR USE ON SYMONS V-SCREENS*

Refer to NORDBERG drawing CV-171 Rev. A for cloth measurements.

U.S. Std. No.	Decimal Equivalent	Nearest Opening Commercially Available With Our Recommended Wire Diameter	Recommended Wire Diameter	Percent Open Area
3	.250"	.250"	.063"	63.8
3-1/2	.223"	.223"	.063"	60.9
4	.187"	.187"	.054"	60.3
5	.157"	.159"	.041"	63.2
6	.132"	.132"	.035"	62.7
7	.111"	.111"	.032"	60.4
8	.0937"	.093"	.032"	55.4
10	.0787"	.080"	.025"	57.8
12	.0661"	.066"	.025"	52.7
14	.0555"	.057"	.020"	54.9
16	.0469"	.0465"	.016"	55.4
18	.0394"	.0396"	.016"	50.8
20	.0331"	.0325"	.013"	51.1

*If lightweight material is being screened, bolting cloth with finer wire diameters can be considered in place of heavier wire diameters as shown above.

SCREEN SIZING INFORMATION

CAPACITY CALCULATION

Once the type of screen is selected it then becomes necessary to determine the size of screen. In some instances it may be necessary to figure a quantity of screens when a single size unit is not adequate for the duty.

There is no substitute for experience, but some type of reference must be available to calculate theoretical screen area. This is the capacity chart which is a guide and must be used with discretion.

Factor A — TPH passing through a square foot of screen surface

Factor B — Percent oversize in feed to deck

Factor C — Percent halfsize in feed to deck

Factor D — Deck location

Factor E — Wet Screening

Factor F — Material weight

Factor G — Surface open area

Factor H — Shape of opening

From the above, a formula was developed to be applied to the operating conditions of the screen application being considered. This formula is as follows:

$$\text{Theoretical Area Required} = \frac{\text{STPH through opening (undersize)}}{A \times B \times C \times D \times E \times F \times G \times H} = \text{Square Feet}$$

The above formula is used in all the calculations. In multiple deck screens, each deck must be figured separately using changing conditions from one deck to another.

There is no substitute for experience. Practical experience or operators demand will often overrule the theoretical calculations arrived at when using a capacity chart.

There are many hidden factors unaccountable in a formula and we make special mention of just a few.

SCREEN EFFICIENCY

Efficiency is defined as the percent of undersize in the feed, that actually passes through the screen surface or

$$\text{Efficiency} = \frac{\text{\% of undersize in feed that actually passes}}{\text{\% undersize in feed that should pass}}$$

In calculating screen area the logical approach is to figure 100% efficiency. However, this is not practical because of the many variables encountered in screening. All materials screen somewhat differently. They may look alike but the general character of the material itself determines the rate of screening through a given hole. Moisture content, near size, particle shape, density can be some of the uncontrollable factors that govern efficiency. Sometimes extra screening area will help offset these factors, but it is no guarantee.

BED THICKNESS

Some of the capacity charts include a formula on bed thickness. It is important to check this. It can be deceiving. Bed thickness is figured on total feed on the deck and does not take into consideration the top size piece. Consequently, using the mathematical formula, bed thickness could work out to 3" depth by formula but feed contains 6" pieces. This may require some review and evaluation. The capacity charts include a formula for checking bed thickness.

DAMP, STICKY, OR MOIST CONDITION

Material in this condition can cause many problems when trying to separate. Size of separation will be determining factor.

SLOPE OF THE SCREEN

This applies to inclined screen only. Using the mathematical formula a 20° slope has a factor of 1.0. Reducing the slope below 20° affects travel rate of material and can reduce capacity capability of the screen. Often times a change in cloth opening is necessary to compensate for change in slope.

APERTURE IN THE SURFACE

The square opening factor is 1.0 and consequently does not change the formula. Openings other than square can affect capacity which is considered under Factor H in formula.

PARTICLE SHAPE

Material to be screened can be of many shapes. Cubes, wedges, slivers and flats are the most common. There is no factor to compensate for particle shape.

Once again, these are hidden factors in screening application — ones which cannot be given a number and put into a formula. Usually an increase in the size of the screen will help counter act these factors. There is no absolute guarantee that the theoretical calculations will be 100% correct in field operations.

The following pages give the factors which apply to the individual screens. Should you have any unusual problems, please consult the factory.

NORDBERG CAPACITY GUIDE

$$\text{Theoretical Are Required} = \frac{\text{Total TPH thru opening (undersize)}}{A \times B \times C \times D \times E \times F \times G \times H} = \text{Square Feet}$$

Basic Operating Conditions
Feed to screen contains 50% oversize, 25% half size. Objective efficiency is 92 - 95%. Operating slope is 20°.*

*Reducing the slope below 20° will affect travel rate of material and can reduce capacity. To compensate for reduced slope use the following as a guide: Contact Nordberg for approval to operate at reduced slope.

Slope	% Rate Capacity
17.5°	90-93%
15°	80-85%
12.5°	70-75%
10°	65-70%

FACTOR A
(TPH Passing a Square Foot of Screen Surface)

(Surface Square Opening)				Decimal Equiv.	% Open Area	Crushed Stone	Sand and Gravel
#20				0.0331	44	0.18	0.24
#14				0.0555	44	0.32	0.40
1/16"				0.0625	48	0.40	0.49
#12				0.0661	42	0.42	0.51
#10				0.0787	45	0.51	0.61
3/32" (#8)				0.0937	45	0.56	0.70
1/8"				0.125	44	0.66	0.79
#6				0.132	47	0.70	0.83
3/16" (#4)				0.187	45	0.89	1.08
(In.)	(mm)	(In.)	(mm)				
1/4"	6			0.250	46	1.10	1.38
		5/16"	24	0.3125	49	1.30	1.60
3/8"	9			0.375	51	1.47	1.85
		7/16"	11	0.432	53	1.62	2.05
1/2"	12			0.500	55	1.75	2.24
		9/16"	14	0.562	58	1.88	2.34
5/8"	16			0.625	59	1.95	2.45
		11/16"	17	0.688	59	2.05	2.51
3/4"	19			0.750	61	2.15	2.68
		13/16"	20	0.812	63	2.22	2.76
7/8"	22			0.875	63	2.28	2.84
		15/16"	24	0.938	62	2.36	2.93
1"	25			1.000	64	2.44	3.00
		1-1/8"	28	1.125	67	2.54	3.15

FACTOR A
(continued)

(Surface Square Opening)				Decimal Equiv.	% Open Area	Crushed Stone	Sand and Gravel
(In.)	(mm)	(In.)	(mm)				
1-1/4"	31			1.250	64	2.64	3.29
		1-5/16"	33	1.312	66	2.69	3.35
1-3/8"	34			1.375	66	2.74	3.40
		1-1/2"	37	1.500	69	2.84	3.50
1-3/4"	44			1.750	68	3.04	3.74
		1-13/16"	45	1.812	68	3.14	3.86
2"	51			2.000	71	3.23	3.97
		2-1/4"	57	2.250	70	3.45	4.28
2-5/16"	59			2.312	71	3.56	4.44
		2-1/2"	63	2.502	72	3.66	4.57
2-3/4"	70			2.750	74	3.92	4.80
		3"	76	3.000	74	4.14	5.04
3-1/4"	82			3.250	75	4.35	5.32
		3-1/2"	88	3.500	77	4.58	5.60
3-3/4"	95			3.750	74	4.79	5.90
		4"	102	4.000	75	5.02	6.21
4-1/2"	114			4.500	74	5.42	6.75
		5"	127	5.000	76	5.85	7.30
5-1/2"	139			5.500	72	6.30	7.85
		6"	152	6.000	74	6.80	8.30

FACTOR B

(Percent of Oversize in Feed to Deck)

% Oversize	0	1	2	3	4	5	6	7	8	9	10
Factor B	1.60	1.58	1.57	1.56	1.55	1.54	1.52	1.51	1.50	1.49	1.48
% Oversize	11	12	13	14	15	16	17	18	19	20	21
Factor B	1.46	1.45	1.44	1.43	1.42	1.40	1.39	1.38	1.37	1.36	1.34
% Oversize	22	23	24	25	26	27	28	29	30	31	32
Factor B	1.33	1.32	1.31	1.30	1.28	1.27	1.26	1.25	1.24	1.23	1.22
% Oversize	33	34	35	36	37	38	39	40	41	42	43
Factor B	1.21	1.20	1.19	1.17	1.16	1.15	1.14	1.13	1.11	1.10	1.08
% Oversize	44	45	46	47	48	49	50	51	52	53	54
Factor B	1.07	1.06	1.04	1.03	1.02	1.01	1.00	.99	.98	.97	.96
% Oversize	55	56	57	58	59	60	61	62	63	64	65
Factor B	.95	.93	.92	.91	.90	.89	.87	.86	.84	.83	.82
% Oversize	66	67	68	69	70	71	72	73	74	75	76
Factor B	.81	.80	.79	.78	.77	.75	.74	.73	.72	.71	.69
% Oversize	77	78	79	80	81	82	83	84	85	86	87
Factor B	.68	.66	.65	.64	.62	.60	.59	.57	.56	.53	.51
% Oversize	88	89	90	91	92	93	94	95	96	97	98
Factor B	.48	.46	.44	.40	.37	.33	.29	.24	.20	.15	.10

FACTOR C

(Percent Half Size in Feed to Deck)

% 1/2 Size Opening	0	1	2	3	4	5
Factor C	.70	.71	.72	.73	.74	.76
% 1/2 Size Opening	6	7	8	9	10	11
Factor C	.77	.78	.79	.80	.82	.83
% 1/2 Size Opening	12	13	14	15	16	17
Factor C	.84	.85	.86	.88	.89	.90
% 1/2 Size Opening	18	19	20	21	22	23
Factor C	.91	.92	.94	.95	.96	.97
% 1/2 Size Opening	24	25	26	27	28	29
Factor C	.98	1.00	1.01	1.02	1.03	1.04
% 1/2 Size Opening	30	31	32	33	34	35
Factor C	1.06	1.07	1.08	1.10	1.11	1.13
% 1/2 Size Opening	36	37	38	39	40	41
Factor C	1.14	1.15	1.17	1.18	1.20	1.21
% 1/2 Size Opening	42	43	44	45	46	47
Factor C	1.23	1.25	1.27	1.29	1.30	1.32
% 1/2 Size Opening	48	49	50	51	52	53
Factor C	1.34	1.36	1.38	1.40	1.42	1.45
% 1/2 Size Opening	54	55	56	57	58	59
Factor C	1.47	1.50	1.53	1.56	1.59	1.62
% 1/2 Size Opening	60	61	62	63	64	65
Factor C	1.65	1.69	1.73	1.77	1.81	1.85

FACTOR C

(continued)

% 1/2 Size Opening Factor C	66 1.88	67 1.92	68 1.96	69 2.00	70 2.04	71 2.08
% 1/2 Size Opening Factor C	72 2.12	73 2.17	74 2.21	75 2.26	76 2.30	77 2.35
% 1/2 Size Opening Factor C	78 2.40	79 2.45	80 2.50	81 2.55	82 2.60	83 2.65
% 1/2 Size Opening Factor C	84 2.70	85 2.75	86 2.80	87 2.85	88 2.90	89 2.95
% 1/2 Size Opening Factor C	90 3.00	91 3.05	92 3.10	93 3.15	94 3.20	95 3.25

FACTOR D

(Deck Location / Deck Efficiency)

Deck	Top	Second	Third	Fourth
Factor D	1.00	0.90	0.80	0.70

FACTOR E

(Wet Screening)

Lbs. Per Cu. Ft.	1/32"	1/16"	1/8"	3/16"	1/4"	5/16"	3/8"	1/2"	3/4"	1" 1-1/2"
Factor E	1.00	2.00	2.50	2.50	2.25	2.00	1.50	1.30	1.20	1.15

FACTOR F

(Material Weight)

Lbs. Per Cu. Ft.	150	125	100	90	80	75	70	60	50	30
Factor F	1.50	1.25	1.00	0.90	0.80	0.75	0.70	0.60	0.50	0.30

FACTOR G

(Screen Surface Open Area)

$$\text{Factor G} = \frac{\text{\% open area of woven wire cloth being used}}{\text{\% open area indicated with Factor A}}$$

FACTOR H

(Shape of Surface Opening)

Shape	Factor
Square	1.00
Round	0.80
Slot (3 to 4 times width)	1.15
Slot (more than 4 times width)	1.20

Depth of Bed

$$DBF = \frac{F \times C}{5 \times T \times W} = \text{Bed in inches}$$

$$DBD = \frac{O \times C}{5 \times T \times W} = \text{Bed in inches}$$

DBF = Depth of Feed End
DBD = Depth at Discharge End

Bed thickness is figured on feed to the deck and oversize off the deck. Calculations are based on volume and do not recognize actual dimensions of largest piece. Calculations could work out to be less than largest size piece and further evaluation is necessary in these instances.

F = Total Feed to deck
C = Number of cubic feet per ton of material
T = Rate of travel in fpm (average 60-120 fpm)
W = Width of screen in feet
O = Oversize in feed to deck

As a guide, bed depth at the discharge end of the screen should not exceed four times the size of the surface opening when separating material weighing 100 lbs. per cu. ft.

U.S. SIEVE SERIES AND TYLER EQUIVALENTS

A.S.T.M. - E-11-61

Sieve Designation		Sieve Opening		Nominal Wire Diameter		Tyler Screen Scale Equivalent Designation
Standard	Alternate	mm	In. (approximate equivalents)	mm	In. (approximate equivalents)	
107.6mm	4.24"	107.6	4.24	6.40	.2520	--
101.6mm	4" (a)	101.6	4.00	6.30	.2480	--
90.5mm	3-1/2"	90.5	3.50	6.08	.2394	--
76.1mm	3"	76.1	3.00	5.80	.2283	--
64.0mm	2-1/2"	64.0	2.50	5.50	.2165	--
53.8mm	2.12"	53.8	2.12	5.15	.2028	--
50.8mm	2" (a)	50.8	2.00	5.05	.1988	--
45.3mm	1-3/4"	45.3	1.75	4.85	.1909	--
38.1mm	1-1/2"	38.1	1.50	4.59	.1807	--
32.0mm	1-1/4"	32.0	1.25	4.23	.1665	--
26.9mm	1.06"	26.9	1.06	3.90	.1535	1.050"
25.4mm	1" (a)	25.4	1.00	2.80	.1496	.883"
22.6mm*	7/8"	22.6	0.875	3.50	.1378	.742"
19.0mm	3/4"	19.0	0.750	3.30	.1299	.624"
16.0mm*	5/8"	16.0	0.625	3.00	.1181	.525"
13.5mm	.530"	13.5	0.630	2.75	.1083	.525"
12.7mm	1/2" (a)	12.7	0.500	2.67	.1051	--
11.2mm*	7/16"	11.2	0.438	2.45	.0965	.441"
9.51mm	3/8"	9.51	0.375	2.27	.0894	.371"
8.00mm*	5/16"	8.00	0.312	2.07	.0815	2-1/2 mesh
6.73mm	.265"	6.73	0.265	1.87	.0736	3 mesh
6.35mm	1/4" (a)	6.35	0.250	1.82	.0717	--
5.66mm*	No. 3-1/2	5.66	0.223	1.68	.0661	3-1/2 mesh
4.76mm	No. 4	4.76	0.187	1.54	.0606	4 mesh
4.00mm*	No. 5	4.00	0.157	1.37	.0539	5 mesh
3.36mm	No. 6	3.36	0.132	1.23	.0484	6 mesh
2.83mm*	No. 7	2.83	0.111	1.10	.0430	7 mesh
2.38mm	No. 8	2.38	0.0937	1.00	.0394	8 mesh
2.00mm*	No. 10	2.00	0.0787	.900	.0354	9 mesh
1.68mm	No. 12	1.68	0.0661	.810	.0319	10 mesh
1.41mm*	No. 14	1.41	0.0555	.725	.0285	12 mesh
1.19mm	No. 16	1.19	0.0469	.650	.0256	14 mesh
1.00mm*	No. 18	1.00	0.0394	.580	.0228	16 mesh
841 micron	No. 20	0.841	0.0331	.510	.0201	20 mesh
707 micron*	No. 25	0.707	0.0278	.450	.0177	24 mesh
595 micron	No. 30	0.595	0.0234	.390	.0154	28 mesh
500 micron*	No. 35	0.500	0.0197	.340	.0134	32 mesh
420 micron	No. 40	0.420	0.0165	.290	.0114	35 mesh

U.S. SIEVE SERIES AND TYLER EQUIVALENTS

A.S.T.M. - E-11-61
(continued)

Sieve Designation		Sieve Opening		Nominal Wire Diameter		Tyler Screen Scale Equivalent Designation
Standard	Alternate	mm	In. (approximate equivalents)	mm	In. (approximate equivalents)	
354 micron*	No. 45	0.354	0.0139	.247	.0097	42 mesh
297 micron	No. 50	0.297	0.0117	.215	.0085	48 mesh
250 micron*	No. 60	0.250	0.0098	.108	.0071	60 mesh
210 micron	No. 70	0.210	0.0083	.152	.0060	65 mesh
177 micron*	No. 80	0.177	0.0070	.131	.0052	80 mesh
149 micron	No. 100	0.149	0.0059	.110	.0043	100 mesh
125 micron*	No. 120	0.125	0.0049	.091	.0036	115 mesh
105 micron	No. 140	0.105	0.0041	.076	.0030	150 mesh
88 micron*	No. 170	0.088	0.0035	.064	.0025	170 mesh
74 micron	No. 200	0.074	0.0029	.053	.0021	200 mesh
63 micron*	No. 230	0.063	0.0025	.044	.0017	250 mesh
53 micron	No. 270	0.053	0.0021	.037	.0015	270 mesh
44 micron*	No. 325	0.044	0.0017	.030	.0012	325 mesh
37 micron	No. 400	0.037	0.0015	.025	.0010	400 mesh

These sieves correspond to those proposed as an International (ISO) Standard. It is recommended that wherever possible these sieves be included in all sieve analysis data or reports intended for international publication.

(a) These sieves are not in the fourth root of 2 Series, but they have been included because they are in common usage.

SIMPLIFIED PRACTICE RECOMMENDATION SCHEDULE OF WIRE DIAMETERS

Opening		MEDIUM LIGHT		MEDIUM		MEDIUM HEAVY		HEAVY	
(mm)	(In.)	Wire Diameter (In.)	% Area Open	Wire Diameter (In.)	% Area Open	Wire Diameter (In.)	% Area Open	Wire Diameter (In.)	% Area Open
102	4"	.500	79.0	.625	74.8	.750	70.9	1.000	64.0
88	3-1/2"	.4375	79.0	.500	76.6	.625	72.0	.750	67.8
76	3"	.4375	76.2	.500	73.5	.625	68.5	.750	64.0
70	2-3/4"	.375	77.4	.4375	74.4	.500	71.6	.625	66.4
63	2-1/2"	.375	75.6	.4375	72.4	.500	69.4	.625	64.0
57	2-1/4"	.375	73.4	.4375	70.1	.500	66.9	.625	61.2
51	2"	.3125	74.8	.375	70.9	.500	64.0	.625	58.0
44	1-3/4"	.3125	71.9	.375	67.8	.4375	64.0	.500	60.5
37	1-1/2"	.250	73.4	.3125	68.5	.375	64.0	.500	56.3
34	1-3/8"	.250	71.5	.3125	66.5	.375	61.6	.4375	57.5
31	1-1/4"	.250	69.4	.3125	64.0	.375	59.2	.4375	54.8
28	1-1/8"	.225	69.6	.250	67.0	.3125	61.0	.375	55.7
25	1"	.225	66.6	.250	64.0	.3125	58.0	.375	52.9
22	7/8"	.207	65.3	.225	63.3	.250	60.5	.3125	54.3
19	3/4"	.192	63.4	.207	61.4	.250	56.3	.3125	49.8
16	5/8"	.177	60.7	.192	58.5	.225	54.0	.250	51.0
14	9/16"	.162	61.0	.177	57.6	.192	55.0	.225	50.7
12	1/2"	.162	57.1	.177	54.5	.192	52.2	.207	49.8
11	7/16"	.148	55.8	.162	53.2	.177	50.7	.192	48.3
9	3/8"	.135	54.1	.148	51.4	.162	48.7	.177	46.1
8	5/16"	.120	52.2	.135	48.8	.148	46.0	.162	43.4
6	1/4"	.105	49.6	.120	45.6	.135	42.2	.148	39.4
4	3/16"	.080	49.1	.092	45.1	.120	37.2	.135	33.8
3.9	5/32"	.063	51.2	.080	43.5	.105	36.0	.120	32.2
3	1/8"	.054	48.7	.072	40.2	.092	33.4	.105	29.5
2	3/32"	.041	47.6	.047	45.2	.063	25.0	.080	29.6
1.5	1/16"	.035	42.3	.041	37.0	.047	33.2	.063	24.6

The following recommendation covering wire diameters for screens for sizing mineral aggregates, has the approval of the National Sand and Gravel Association, National Crushed Stone Association, National Slag Association, Various Government departments and various makers of screens and screening equipment.

TABLE OF WIRE DIAMETERS

Standard wire diameters in decimal parts of an inch, and equivalent wire gauge in five gauge systems. Pounds per lineal foot and lineal feet per pound refer to SAE-1008 steel.

Industrial Wire Cloth Standard Weight Steel			Other Wire Gauges — Decimal Equivalents of Various Gauge Numbers				
Diameter Decimal of U.S. Inch	Pounds Per Lineal Foot	Lineal Feet Per Pound	Gauge Number	Washburn & Moen	Old English	Birmingham or Stubs	Brown & Sharp or American
.4375	.5150	1.959					
.375	.3751	2.666					
.3125	.2605	3.839					
.307	.2514	3.977	0	.3065	.340	.340	.3240
.283	.2136	4.681	1	.2830	.300	.300	.2893
.263	.1845	5.420	2	.2625	.284	.284	.2576
.250	.1667	5.999	3	.2437	.259	.259	.2294
.225	.1350	7.407	4	.2253	.238	.238	.2043
.207	.1143	8.750	5	.2070	.220	.220	.1819
.192	.09832	10.170	6	.1920	.203	.203	.1620
.177	.08356	11.970	7	.1770	.180	.180	.1442
.162	.07000	14.290	8	.1620	.165	.165	.1284
.148	.05842	17.120	9	.1483	.148	.148	.1144
.135	.04861	20.570	10	.1350	.134	.134	.1018
.120	.03841	26.040	11	.1205	.120	.120	.0907
.105	.02941	34.000	12	.1055	.109	.109	.0808
.092	.02258	44.300	13	.0915	.095	.095	.0719
.080	.01707	58.580	14	.0800	.083	.083	.0640
.072	.01383	72.320	15	.0720	.072	.072	.0570
.063	.01059	94.420	16	.0625	.065	.065	.0508
.054	.007778	128.600	17	.0540	.058	.058	.0452
.047	.005892	169.700	18	.0475	.049	.049	.0403
.041	.004484	223.000	19	.0410	.040	.042	.0358
.035	.003267	306.100	20	.0348	.035	.035	.0319
.032	.002731	366.100	21	.0317	.0315	.032	.0284
.028	.002091	478.200	22	.0286	.0295	.028	.0253
.025	.001667	599.900	23	.0258	.027	.022	.0225
.023	.001411	708.700	24	.0230	.025	.022	.0201
.020	.001067	937.300	25	.0204	.023	.020	.0179
.018	.0008642	1157.000	26	.0181	.0205	.018	.0159
.017	.0007708	1297.000	27	.0173	.0187	.016	.0141
.016	.0006828	1465.000	28	.0162	.0165	.014	.0126
.015	.0006001	1666.000	29	.0150	.0155	.013	.0112
.014	.0005228	1913.000	30	.0140	.0137	.012	.0100
.0135	.0004861	2057.000	31	.0132	.0122	.010	.0089
.013	.0004508	2218.000	32	.0128	.0112	.009	.0079

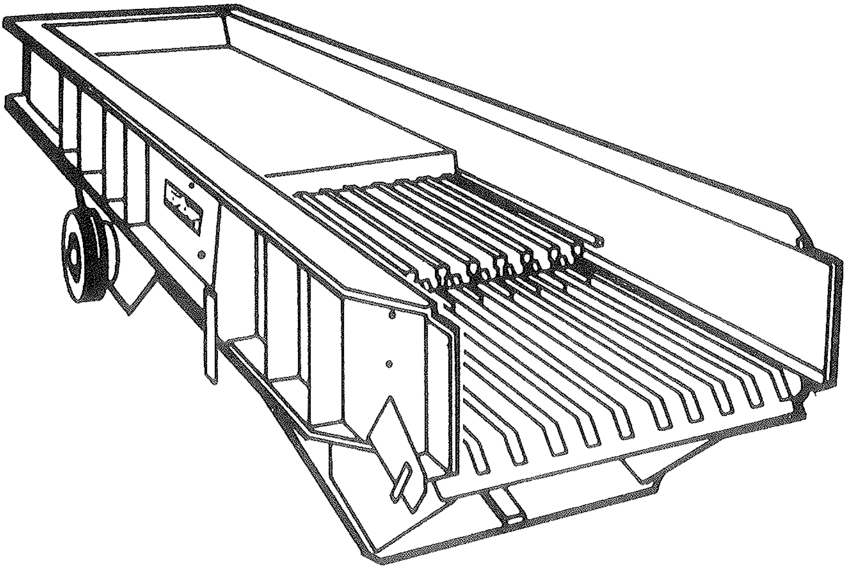
TABLE OF WIRE DIAMETERS
(continued)

Industrial Wire Cloth Standard			Other Wire Gauges				
Weight Steel			Decimal Equivalents of Various Gauge Numbers				
Diameter Decimal of U.U. Inch	Pounds Per Lineal Foot	Lineal Feet Per Pound	Gauge Number	Washburn & Moen	Old English	Birmingham or Stubs	Brown & Sharp or American
.012	.0003841	2604.00					
.011	.0003227	3098.00	33	.0118	.0102	.008	.0070
.010	.0002667	3749.00	34	.0104	.0095	.007	.0063
.0095	.0002407	4154.00	35	.0095	.0090	.005	.0056
.009	.0002160	4629.00	36	.0090	.0075	.004	.0050
.0085	.0001927	5189.00	37	.0085	.0065		.0044
.008	.0001707	5858.00	38	.0080	.0057		.0039
.0075	.0001500	6665.00	39	.0075	.0050		.0035
.007	.0001307	7652.00	40	.0070	.0450		.0031
.0065	.0001127	8873.00					
.006	.00009602	10415.00					
.0055	.00008068	12394.00					
.005	.00006668	14997.00					
.0045	.00005401	18515.00					

Nordberg®

A Nordberg Group Company

Feeders



INTRODUCTION TO NORDBERG FEEDERS

Feeders are used for a wide variety of applications such as metering and transferring of material from bins, hoppers, silos and storage piles to crushers, screens and belt conveyors and protecting other equipment from impact loads.

Nordberg offers different types of feeders to meet varying requirements. Contact Nordberg for a recommendation concerning your particular feeder application.

The following is a brief description of the Nordberg feeder line. Refer to literature for further details.

Nordberg Heavy-Duty Vibrating Pan Feeders

The Nordberg heavy-duty pan feeder is designed for metering flow of material in applications involving severe loading and heavy burdens. Either mild steel or AR steel abrasion resistant liners are normally used to protect the pan.

The vibrating assembly which is connected directly to the pan assures positive action under the most adverse of loading conditions.

Features include solid machined eccentric exciter shafts, coil spring supports and stress relieved feeder body. Components are huck bolted for vibration secure fastening.

Standard Nordberg heavy-duty pan feeders are available in sizes ranging from 18" wide x 6' long to 7' wide x 24' long.

Nordberg Heavy-Duty Vibrating Grizzly Feeders

The standard Nordberg heavy-duty grizzly feeder is a heavy-duty pan feeder with grizzly section(s) following the pan surface. It is intended for impact loading and large burdens common in the feeding and scalping of ROQ (run of quarry) and ROM (run of mine) material prior to crushing and/or conveying. Maximum lump sizes accommodated can range up to 6' cubes.

The grizzly feeder design incorporates three elements...a deep sides feeder trough referred to as the pan followed by one or two grizzly sections, a vibrator assembly and a spring support system. The vibrator assembly imparts a vigorous straight line motion directly to the feeder pan and grizzly section(s).

Options include mild steel or AR steel replaceable liners, fixed or adjustable grizzly bars, single and double step grizzly sections with a variation of openings. Special arrangements where pan sections proceed and following grizzly sections are also available on request.

Heavy-duty grizzly feeders are available in sizes ranging from 2' wide x 8' long to 7' wide x 25' long.

VIBRATING FEEDER SELECTION

Two steps are required in selecting the proper feeder for a specific installation:
1. Obtaining basic application information.
2. Following a selection procedure.

Information Required:
1. Largest size material size.
2. Approximate analysis of material size.
3. Desired capacity.
4. Type and description of material.
5. Type of installation.

Selection Procedures

Step 1. From Chart I, select feeder width factor appropriate to the application. Multiply the factor by the size of the largest piece in the feed to obtain minimum feeder width.

Step 2. Check the minimum width determined in Step 1 with capacity in Chart II. Note required slope angle to produce desired capacity. If necessary, increase feeder width to obtain desired capacity. There may be several combinations of slope and width which will produce the capacity required.

Factors such as headroom, depth of bed, unit cost, width of conveyor or crusher and future capacity requirements should be considered prior to final selection.

Step 3. Feeder length should not be shorter than that needed to retain material at its angle of repose on the feeder pan when the feeder is shut down...plus a 6" to 12" safety factor to prevent possibility of free flow. Feeder length must be sufficient to convey the required distance.

Step 4. Select slope angle to best suit required capacity from Chart II and length to retain material angle of repose from illustration B. A sketch drawn to scale showing slope and material repose angles will assist in showing relationship between feeder length and slope.

Step 5. When a four-sided hopper is used, refer to Chart I and illustration B to determine minimum hopper throat opening. Simply multiply the largest material lump size by the hopper throat opening factor to obtain this figure.

Step 6. Make final feeder selection. Often, more than one size and type of feeder will satisfy the application requirements. The final selection will depend on various factors including:

a. Size and type of crusher when feeding directly to crusher.
b. Conveyor width when feeding in line with material travel.
c. Size of material handled and loading on feeder.
d. Hopper capacity required. With a larger feeder there is more hopper capacity.
e. Headroom available. A sloped feeder normally requires more headroom.
f. Amount of grizzly length required to remove fines.
g. Price. A smaller or lighter duty feeder is less expensive.
h. Future requirements. Will a larger crusher or conveyor be installed? Will plant capacity be increased?

INTRODUCTION TO NORDBERG FEEDERS
(continued)

CHART I. SELECTION FACTOR

Percent of Large* Material in Feed	Feeder Width Factor	Hopper Throat Opening Factor
Less than 10%	1	1-1/2
10% - 40%	1-1/2	2
40% - 60%	2	2-1/2
60% - 80%	2-1/2	3
80% - 100%	3	3-1/2

* Percent of material in feed which ranges in size from 80% of maximum size through maximum size.

CHART II. MECHANICAL VIBRATING FEEDER CAPACITY

Width		Slope of pan/tons per hour			
(In.)	(mm)	0°	5°	10°	15°
12	305	120	150	180	220
24	609	240	300	360	430
36	914	360	450	540	650
48	1219	480	600	720	860
60	1524	600	750	900	1080
72	1828	720	900	1080	1300
84	2133	840	1050	1260	1510
96	2438	970	1200	1450	1740

Capacities are based on: Material with good conveying characteristics like 3"x1" crushed stone, 12" material depth, 100 lbs per cubic foot material density and Simplicity recommended hopper design.

Simplicity engineers will be pleased to assist you in specific feeder selections, and in determining other factors such as grizzly size, hopper configuration and mounting methods.

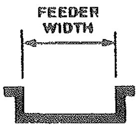


ILLUSTRATION A

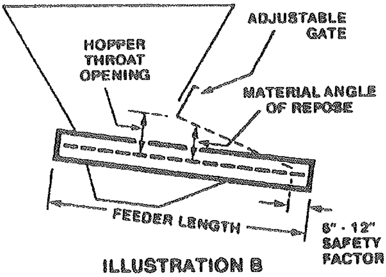


ILLUSTRATION B

NORDBERG MODEL OA-10-A5B VIBRATING PAN FEEDER

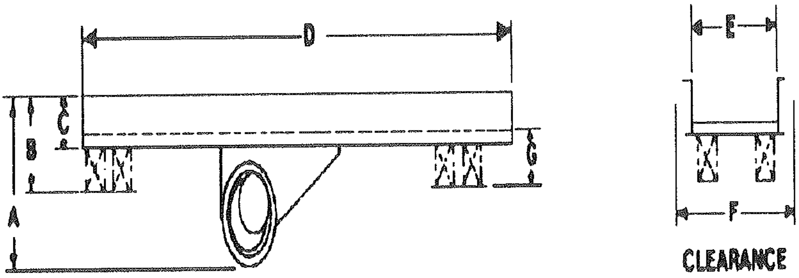
Specifications

Description of Basic Unit
Nordberg Model OA-10-A5B Vibrating Pan Feeder with formed pan, mild steel wear liners covering the pan and entire sides, oil lubricated vibrator assembly, coil spring mounting assembly located at each corner, feeder sheave, motor sheave, V-belts, pivot motor base, but not including V-belt guard, motor or motor controls.

SIZE	BRG SIZE	..MOTOR.. NEMA B 1200 RPM	V BELTS	PAN DEPTH	PAN THICK	APPROX. WEIGHT Lbs.	Kgs.
26" x 8'	95mm	7-1/2 HP	C-90	9"	5/16"	4,529	2,054
26" x 10'	95mm	10 HP	C-90	9"	5/16"	5,209	2,363
26" x 12'	95mm	10 HP	C-90	9"	5/16"	5,890	2,672
26" x 14'	95mm	10 HP	C-90	9"	5/16"	6,570	2,980
27.5" x 16'	95mm	20 HP	C-90	9"	3/8"	6,814	3,091
27.5" x 18'	95mm	20 HP	C-90	9"	3/8"	7,186	3,259
27.5" x 20'	95mm	20 HP	C-90	9"	3/8"	7,402	3,357
32" x 8'	95mm	10 HP	C-90	9"	5/16"	5,092	2,310
32" x 10'	95mm	10 HP	C-90	9"	5/16"	5,852	2,654
32" x 12'	95mm	10 HP	C-90	9"	5/16"	6,612	2,999
32" x 14'	95mm	10 HP	C-90	9"	5/16"	7,372	3,344
33.5" x 16'	95mm	25 HP	C-90	9"	3/8"	7,656	3,473
33.5" x 18'	95mm	25 HP	C-90	9"	3/8"	8,073	3,662
33.5" x 20'	95mm	25 HP	C-90	9"	3/8"	8,616	3,908
38" x 8'	95mm	15 HP	C-90	9"	5/16"	5,588	2,535
38" x 10'	95mm	15 HP	C-90	9"	5/16"	6,445	2,923
38" x 12'	95mm	15 HP	C-90	9"	5/16"	7,303	3,313
38" x 14'	95mm	20 HP	C-90	9"	5/16"	8,160	3,701
39.5" x 16'	95mm	25 HP	C-90	9"	3/8"	8,487	3,850
39.5" x 18'	95mm	25 HP	C-90	9"	3/8"	9,031	4,096
39.5" x 20'	95mm	25 HP	C-90	9"	3/8"	9,225	4,184
44" x 8'	95mm	15 HP	C-90	9"	5/16"	6,229	2,825
44" x 10'	95mm	15 HP	C-90	9"	5/16"	7,150	3,243
44" x 12'	95mm	20 HP	C-90	9"	5/16"	8,068	3,660
44" x 14'	95mm	20 HP	C-90	9"	5/16"	8,988	4,077
45.5" x 16'	95mm	30 HP	C-90	9"	3/8"	9,263	4,202
45.5" x 18'	95mm	30 HP	C-90	9"	3/8"	9,856	4,471
45.5" x 20'	95mm	30 HP	C-90	9"	3/8"	10,449	4,740
45.5" x 22'	95mm	30 HP	C-90	9"	3/8"	11,475	5,205
45.5" x 24'	95mm	30 HP	C-90	9"	3/8"	11,906	5,400
50" x 8'	95mm	15 HP	C-90	9"	5/16"	6,805	3,087
50" x 10'	95mm	20 HP	C-90	9"	5/16"	7,804	3,540
50" x 12'	95mm	20 HP	C-90	9"	5/16"	8,803	3,993
50" x 14'	95mm	20 HP	C-90	9"	5/16"	9,803	4,447
51.5" x 16'	95mm	30 HP	C-90	9"	3/8"	10,109	4,585
51.5" x 18'	95mm	30 HP	C-90	9"	3/8"	10,792	4,895
51.5" x 20'	95mm	30 HP	C-90	9"	3/8"	11,475	5,205
51.5" x 22'	95mm	30 HP	C-90	9"	3/8"	12,589	5,701
51.5" x 24'	95mm	30 HP	C-90	9"	3/8"	13,037	5,913

NORDBERG MODEL OA-10-A5B VIBRATING PAN FEEDER

Dimensions



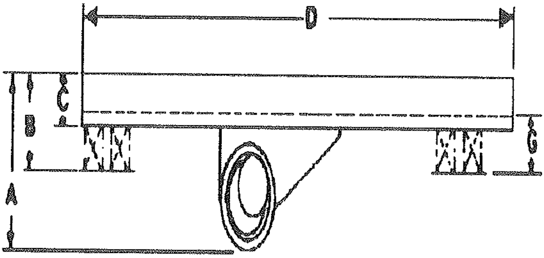
DIMENSION	SIZE (Length x Width) 26" X 8'	26" X 10'	26" X 12'	26" X 14'	32" x 8'	32" X 10'	32" X 12'
A	3'-5"	3'-5"	3'-5"	3'-6"	3'-5"	3'-5"	3'-5"
B	1'-10"	1'-10"	1'-11"	1'-11"	1'-10"	1'-10"	1'-11"
C	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"
D	8'-0"	10'-0"	12'-0"	14'-0"	8'-0"	10'-0"	12'-0"
E	2'-2"	2'-2"	2'-2"	2'-2"	2'-8"	2'-8"	2'-8"
F	3'-6"	3'-6"	3'-6"	3'-6"	4'-0"	4'-8"	4'-0"
G	1'-1"	1'-1"	1'-2"	1'-2"	1'-1"	1'-1"	1'-2"

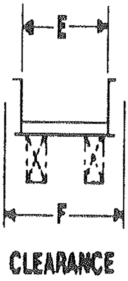
DIMENSION	SIZE (Length x Width) 32" X 14'	38" X 8'	38" X 10'	38" x 12'	38" X 14'	44" X 8'	44" X 10'
A	3'-5"	3'-5"	3'-5"	3'-5"	3'-5"	3'-5"	3'-5"
B	1'-11"	1'-10"	1'-10"	1'-11"	1'-11"	1'-10"	1'-10"
C	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"
D	14'-0"	8'-0"	10'-0"	12'-0"	14'-0"	8'-0"	10'-0"
E	2'-8"	3'-2"	3'-2"	3'-2"	3'-2"	3'-8"	3'-8"
F	4'-0"	4'-6"	4'-6"	4'-6"	4'-6"	5'-0"	5'-0"
G	1'-2"	1'-1"	1'-1"	1'-2"	1'-2"	1'-1"	1'-1"

DIMENSION	SIZE (Length x Width) 44" X 12'	44" X 14'	50" x 8'	50" X 10'	50" X 12'	50" X 14'	
A	3'-5"	3'-5"	3'-5"	3'-5"	3'-5"	3'-5"	
B	1'-11"	1'-11"	1'-10"	1'-10"	1'-11"	1'-11"	
C	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"	
D	12'-0"	14'-0"	8'-0"	10'-0"	12'-0"	14'-0"	
E	3'-8"	3'-8"	4'-2"	4'-2"	4'-2"	4'-2"	
F	5'-0"	5'-0"	5'-6"	5'-6"	5'-6"	5'-6"	
G	1'-2"	1'-2"	1'-1"	1'-2"	1'-2"	1'-2"	

NORDBERG MODEL OA-10-A5B VIBRATING PAN FEEDER

Dimensions (mm)





DIMENSION	SIZE (Length x Width) 26" X 8'	26" X 10'	26" X 12'	26" X 14'	32" x 8'	32" X 10'	32" X 12'
A	1041	1041	1041	1041	1041	1041	1041
B	559	559	584	584	559	559	584
C	305	305	305	305	305	305	305
D	2438	3048	3658	4267	2438	3048	3658
E	661	661	661	661	813	813	813
F	1066	1066	1066	1066	1219	1219	1219
G	330	330	356	356	330	330	356

DIMENSION	SIZE (Length x Width) 32" X 14'	38" X 8'	38" X 10'	38" x 12'	38" X 14'	44" X 8'	44" X 10'
A	1041	1041	1041	1041	1041	1041	1041
B	584	559	559	584	584	559	559
C	305	305	305	305	305	305	305
D	4267	2438	3048	3658	4267	2438	3048
E	813	965	965	965	965	1117	1117
F	1219	1371	1371	1371	1371	1524	1524
G	356	330	330	356	356	330	330

DIMENSION	SIZE (Length x Width) 44" X 12'	44" X 14'	50" x 8'	50" X 10'	50" X 12'	50" X 14'	
A	1041	1041	1041	1041	1041	1041	
B	584	584	559	559	584	584	
C	305	305	305	305	305	305	
D	3658	4267	2438	3048	3658	4267	
E	1117	1117	1270	1270	1270	1270	
F	1524	1524	1676	1676	1676	1676	
G	356	356	330	330	356	356	

NORDBERG VIBRATING GRIZZLY FEEDER WITH ONE GRIZZLY SECTION

Specifications

Description of Basic Unit
Nordberg Heavy Duty Vibrating Grizzly Feeder with solid pan followed by one grizzly section, mild steel liners on pan and sides, oil lubricated vibrator assembly, coil spring mounting assembly, feeder sheave, motor sheave, V-belts, pivot motor base, but not including V-belt guard, motor or motor controls.

SIZE	TYPE CONST	MODEL	GRIZZLY LENGTH	...MOTOR... HP NEMA B	RPM	APPROX. WEIGHT Lbs.	Kgs.
28" x 8'	1	OA-10-NB	1-3'	5 HP	1200	4,300	1,950
28" x 10'	1	OA-10-NB	1-3'	10 HP	1200	4,700	2,132
30" x 8'	1	OA-10-NB	1-3'	10 HP	1200	4,500	2,041
30" x 10'	1	OA-10-NB	1-3'	10 HP	1200	4,900	2,223
33" x 10'	2	OA-120C	1-3'	20 HP	1800	8,700	3,946
33" x 12'	2	OA-A5B	1-4'	20 HP	1800	8,200	3,719
33" x 14'	2	OA-120C	1-5'	20 HP	1800	10,100	4,581
39" x 10'	2	OA-A5B	1-3'	20 HP	1200	8,300	3,765
39" x 12'	2	OA-A5B	1-4'	20 HP	1200	9,100	4,128
39" x 14'	2	OA-A5B	1-5'	25 HP	1200	9,900	4,491
39" x 16'	2	OA-A5B	1-5'	25 HP	1200	10,500	4,763
39" x 18'	2	OA-120C	1-5'	25 HP	1800	12,500	5,670
45" x 10'	2	OA-A5B	1-3'	20 HP	1200	9,000	4,082
45" x 12'	2	OA-A5B	1-4'	25 HP	1200	9,900	4,491
45" x 14'	2	OA-A5B	1-5'	25 HP	1200	10,800	4,899
45" x 16'	2	OA-A5B	1-5'	25 HP	1200	11,400	5,171
45" x 18'	2	OA-A5B	1-5'	25 HP	1800	12,100	5,488
45" x 20'	2	OA-A5B	1-5'	30 HP	1200	12,800	5,806
45" x 22'	3	OA-120C	1-5'	40 HP	1800	17,500	7,938
45" x 24'	2	OA-120C	1-5'	40 HP	1800	18,300	8,301
51" x 10'	2	OA-A5B	1-5'	20 HP	1200	9,100	4,128
51" x 12'	2	OA-A5B	1-5'	25 HP	1200	10,200	4,627
51" x 14'	2	OA-A5B	1-5'	25 HP	1200	11,400	5,171
51" x 16'	2	OA-A5B	1-5'	30 HP	1200	12,200	5,534
51" x 18'	3	OA-120C	1-5'	30 HP	1800	16,700	7,575
51" x 20'	3	OA-120C	1-5'	40 HP	1800	17,600	7,983
51" x 22'	3	OA-120C	1-5'	40 HP	1800	18,400	8,346
51" x 24'	3	OA-120C	1-5'	50 HP	1800	19,300	8,754

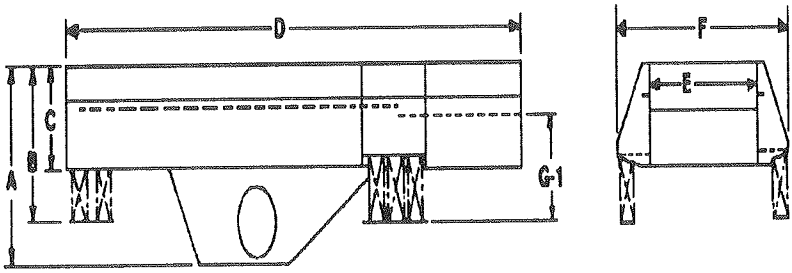
NORDBERG VIBRATING GRIZZLY FEEDER WITH ONE GRIZZLY SECTION

Specifications (Continued)

SIZE	TYPE CONST	MODEL	GRIZZLY LENGTH	..MOTOR.. HP NEMA B	RPM	APPROX. WEIGHT Lbs.	Kgs.
57" x 16'	3	OA-120C	1-5'	30 HP	1800	16,200	7,348
57" x 18'	3	OA-120C	1-5'	30 HP	1800	17,400	7,893
57" x 20'	3	OA-120C	1-5'	40 HP	1800	18,200	8,255
57" x 22'	3	OA-120C	1-5'	40 HP	1800	19,800	8,981
57" x 24'	3	OA-120C	1-5'	50 HP	1800	21,000	9,525
62" x 16'	4	OA-140D	1-5'	50 HP	1800	23,000	10,433
62" x 18'	4	OA-140D	1-5'	50 HP	1800	24,500	11,113
62" x 20'	4	OA-140D	1-5'	60 HP	1800	25,500	11,567
62" x 22'	4	OA-160D	1-5'	60 HP	1800	28,600	12,973
62" x 24'	4	OA-160D	1-5'	60 HP	1800	30,100	13,653
68" x 16'	4	OA-140D	1-5'	50 HP	1800	24,200	10,977
68" x 18'	4	OA-140D	1-5'	60 HP	1800	25,800	11,703
68" x 20'	4	OA-140D	1-5'	60 HP	1800	27,400	12,428
68" x 22'	4	OA-160D	1-5'	60 HP	1800	31,500	14,288
68" x 24'	4	OA-160D	1-5'	75 HP	1800	33,100	15,014
74" x 16'	5	OA-140D	1-5'	60 HP	1800	26,400	11,975
74" x 18'	5	OA-140D	1-5'	60 HP	1800	28,000	12,701
74" x 20'	5	OA-140D	1-5'	60 HP	1800	29,600	13,426
74" x 22'	5	OA-160D	1-5'	75 HP	1800	33,600	15,241
74" x 24'	5	OA-160D	1-5'	75 HP	1800	35,300	16,012
74" x 26'	5	OA-160D	1-5'	100 HP	1800	37,000	17,783
74" x 28'	5	OA-160D	1-5'	100 HP	1800	38,600	17,509
86" x 18'	5	OA-160D	1-5'	75 HP	1800	33,400	15,150
86" x 20'	5	OA-160D	1-5'	75 HP	1800	35,300	16,012
86" x 22'	5	OA-160D	1-5'	100 HP	1800	37,200	16,874
86" x 24'	5	OA-160D	1-5'	100 HP	1800	39,100	17,735

NORDBERG VIBRATING GRIZZLY FEEDER WITH ONE GRIZZLY SECTION

Dimensions



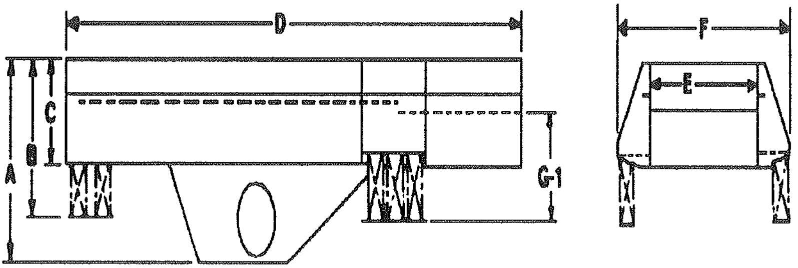
DIMENSION	SIZE (Length x Width) 24" X 8'	24" X 10'	30" X 8'	30" X 10'	33" x 10'	33" X 12'
A	3'-9"	3'-9"	3'-9"	3'-9"	4'-0"	3'-11"
B	2'-6"	2'-6"	2'-6"	2'-6"	4'-2"	3'-11"
C	1'-4"	1'-4"	1'-4"	1'-4"	2'-0"	2'-0"
D	8'-0"	10'-0"	8'-0"	10'-0"	10'-0"	12'-0"
E	2'-0"	2'-0"	2'-6"	2'-6"	2'-9"	2'-10"
F	3'-11"	3'-11"	4'-5"	4'-5"	5'-2"	5'-2"
G-1	1'-6"	1'-6"	1'-6"	1'-6"	1'-8"	1'-8"

DIMENSION	SIZE (Length x Width) 33" X 14'	39" X 10'	39" X 12'	39" X 14'	39" x 16'	39" X 18'
A	3'-11"	3'-11"	3'-11"	3'-11"	3'-11"	4'-0"
B	3'-11"	3'-11"	3'-11"	3'-11"	3'-11"	4'-2"
C	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"
D	14'-0"	10'-0"	12'-0"	14'-0"	16'-0"	18'-0"
E	2'-9"	3'-4"	3'-4"	3'-4"	3'-4"	3'-3"
F	5'-2"	5'-8"	5'-8"	5'-8"	5'-8"	5'-8"
G-1	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"

DIMENSION	SIZE (Length x Width) 45" X 10'	45" X 12'	45" X 14'	45" X 16'	45" x 18'	45" X 20'
A	3'-11"	3'-11"	3'-11"	3'-11"	3'-11"	3'-11"
B	3'-11"	3'-11"	3'-11"	3'-11"	3'-11"	3'-11"
C	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"	2'-0"
D	10'-0"	12'-0"	14'-0"	16'-0"	18'-0"	20'-0"
E	3'-10"	3'-10"	3'-10"	3'-10"	3'-10"	3'-10"
F	6'-2"	6'-2"	6'-2"	6'-2"	6'-2"	6'-2"
G-1	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"	1'-8"

NORDBERG VIBRATING GRIZZLY FEEDER WITH ONE GRIZZLY SECTION

Dimensions (Continued)



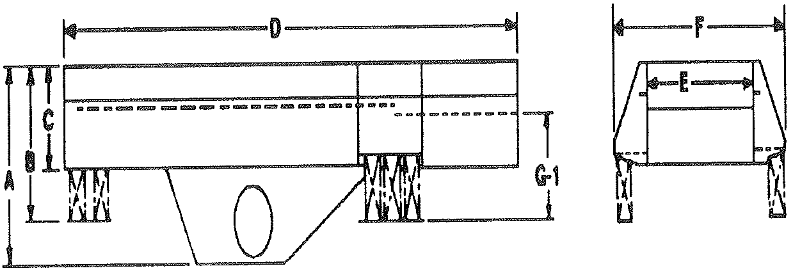
DIMENSION	SIZE (Length x Width) 45" X 22'	45" X 24'	51" X 10'	51" X 12'	51" X 14'	51" X 16'
A	4'-4"	4'-4"	3'-9"	3'-9"	3'-9"	3'-9"
B	3'-4"	3'-4"	3'-11"	3'-11"	3'-11"	3'-11"
C	2'-2"	2'-2"	2'-0"	2'-0"	2'-0"	2'-0"
D	22'-0"	24'-0"	10'-0"	12'-0"	14'-0"	16'-0"
E	3'-9"	3'-9"	4'-4"	4'-4"	4'-4"	4'-4"
F	6'-2"	6'-2"	6'-8"	6'-8"	6'-8"	6'-8"
G-1	2'-5"	2'-5"	1'-8"	1'-8"	1'-8"	1'-8"

DIMENSION	SIZE (Length x Width) 51" X 18'	51" X 20'	51" X 22'	51" X 24'	57" x 16'	57" X 18'
A	4'-6"	4'-6"	4'-6"	4'-6"	4'-6"	4'-6"
B	3'-4"	3'-4"	3'-4"	3'-4"	3'-4"	3'-4"
C	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"
D	18'-0"	20'-0"	22'-0"	24'-0"	16'-0"	18'-0"
E	4'-3"	4'-3"	4'-3"	4'-3"	4'-9"	4'-9"
F	6'-8"	6'-8"	6'-8"	6'-8"	7'-2"	7'-2"
G-1	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"	2'-5"

DIMENSION	SIZE (Length x Width) 57" X 20'	57" X 22'	57" X 24'	62" X 16'	62" x 18'	62" X 20'
A	4'-6"	4'-6"	4'-6"	5'-5"	5'-5"	5'-5"
B	3'-4"	3'-4"	3'-4"	4'-2"	4'-2"	4'-2"
C	2'-2"	2'-2"	2'-2"	3'-0"	3'-0"	3'-0"
D	20'-0"	22'-0"	24'-0"	16'-0"	18'-0"	20'-0"
E	4'-9"	4'-9"	4'-9"	5'-2"	5'-2"	5'-2"
F	7'-2"	7'-2"	7'-2"	7'-10"	7'-10"	7'-10"
G-1	2'-5"	2'-5"	2'-5"	3'-2"	3'-2"	3'-2"

NORDBERG VIBRATING GRIZZLY FEEDER WITH ONE GRIZZLY SECTION

Dimensions (Continued)



DIMENSION	62" X 22'	62" X 24'	68" X 16'	68" X 18'	68" x 20'	68" X 22'
	SIZE (Length x Width)					
A	6'-1"	6'-1"	5'-5"	5'-5"	5'-5"	6'-1"
B	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"
C	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
D	22'-0"	24'-0"	16'-0"	18'-0"	20'-0"	22'-0"
E	5'-2"	5'-2"	5'-8"	5'-8"	5'-8"	5'-8"
F	7'-10"	7'-10"	8'-4"	8'-4"	8'-4"	8'-4"
G-1	3'-2"	3'-2"	3'-2"	3'-2"	3'-2"	3'-2"

DIMENSION	68" X 24'	74" X 16'	74" X 18'	74" X 20'	74" X 22'	74" X 24'
	SIZE (Length x Width)					
A	6'-1"	5'-5'	5'-5"	5'-5"	6'-1"	6'-1"
B	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"
C	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
D	24'-0"	16'-0"	18'-0"	20'-0"	22'-0"	24'-0"
E	5'-8"	6'-2"	6'-2"	6'-2"	6'-2"	6'-2"
F	8'-4"	8'-10"	8'-10"	8'-10"	8'-10"	8'-10"
G-1	3'-2"	3'-2"	3'-2"	3'-2"	3'-2"	3'-2"

DIMENSION	74" X 26'	74" X 28'	86" X 18'	86" X 20'	86" X 22'	86" X 24'
	SIZE (Length x Width)					
A	6'-1"	6'-1'	6'-1"	6'-1"	6'-1"	6'-1"
B	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"
C	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
D	26'-0"	28'-0"	18'-0"	20'-0"	22'-0"	24'-0"
E	6'-2"	6'-2"	7'-2"	7'-2"	7'-2"	7'-2"
F	8'-10"	8'-10"	9'-10"	9'-10"	9'-10"	9'-10"
G-1	3'-2"	3'-2"	3'-2"	3'-2"	3'-2"	3'-2"

NORDBERG VIBRATING GRIZZLY FEEDER WITH TWO GRIZZLY SECTION

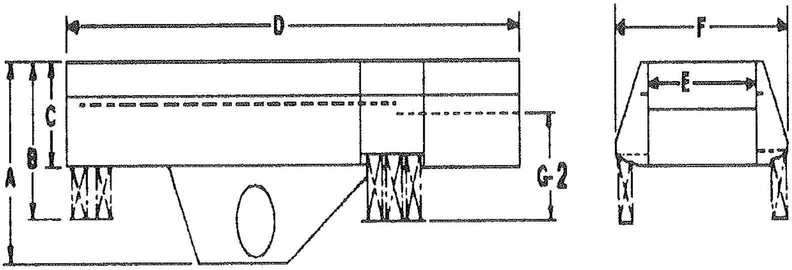
Specifications

Description of Basic Unit
Nordberg Heavy Duty Vibrating Grizzly Feeder with solid pan followed by two grizzly sections, mild steel liners on pan and sides, oil lubricated vibrator assembly, coil spring mounting assembly, feeder sheave, motor sheave, V-belts, pivot motor base, but not including V-belt guard, motor or motor controls.

				...MOTOR...		APPROX. WEIGHT	
SIZE	TYPE CONST	MODEL	GRIZZLY LENGTH	HP NEMA B	RPM	Lbs.	Kgs.
45" x 14'	3	OA-120C	2-3'	30 HP	1800	13,900	6,305
45" x 16'	3	OA-120C	2-4'	30 HP	1800	15,000	6,804
45" x 18'	3	OA-120C	2-4'	30 HP	1800	16,600	7,530
45" x 20'	3	OA-120C	2-5'	40 HP	1800	17,700	8,029
45" x 22'	3	OA-120C	2-5'	40 HP	1800	18,600	8,437
45" x 24'	3	OA-120C	2-5'	50 HP	1800	19,500	8,845
51" x 14'	3	OA-120C	2-3'	30 HP	1800	14,600	6,622
51" x 16'	3	OA-120C	2-3'	30 HP	1800	16,400	7,439
51" x 18'	3	OA-120C	2-4'	30 HP	1800	17,400	7,892
51" x 20'	3	OA-120C	2-5'	40 HP	1800	18,400	8,346
51" x 22'	3	OA-120C	2-5'	50 HP	1800	19,600	8,890
51" x 24'	3	OA-120C	2-5'	50 HP	1800	20,700	9,389
57" x 16'	3	OA-120C	2-4'	30 HP	1800	17,300	7,847
57" x 18'	3	OA-120C	2-4'	40 HP	1800	18,300	8,301
57" x 20'	3	OA-120C	2-5'	50 HP	1800	20,900	9,480
57" x 22'	3	OA-140D	2-5'	50 HP	1800	22,100	10,024
57" x 24'	3	OA-140D	2-5'	50 HP	1800	23,800	10,795
62" x 16'	4	OA-140D	2-4'	50 HP	1800	24,700	11,204
62" x 18'	4	OA-140D	2-4'	60 HP	1800	26,200	11,884
62" x 20'	4	OA-140D	2-5'	60 HP	1800	27,700	12,564
62" x 22'	4	OA-160D	2-5'	75 HP	1800	32,000	14,515
62" x 24'	4	OA-160D	2-5'	75 HP	1800	33,500	15,195
68" x 16'	4	OA-140D	2-4'	60 HP	1800	25,900	11,748
68" x 18'	4	OA-140D	2-4'	60 HP	1800	27,500	12,474
68" x 20'	4	OA-140D	2-5'	60 HP	1800	29,200	13,249
68" x 22'	4	OA-160D	2-5'	75 HP	1800	33,300	15,105
68" x 24'	4	OA-160D	2-5'	75 HP	1800	34,900	15,830
74" x 16'	5	OA-140D	2-4'	60 HP	1800	28,000	12,701
74" x 18'	5	OA-140D	2-4'	75 HP	1800	29,700	13,472
74" x 20'	5	OA-160D	2-5'	75 HP	1800	34,200	15,513
74" x 22'	5	OA-160D	2-5'	75 HP	1800	35,900	16,284
74" x 24'	5	OA-160D	2-5'	100 HP	1800	39,900	18,098
86" x 18'	5	OA-160D	2-5'	75 HP	1800	35,500	16,102
86" x 20'	5	OA-160D	2-5'	100 HP	1800	37,400	16,964

NORDBERG VIBRATING GRIZZLY FEEDER WITH TWO GRIZZLY SECTION

Dimensions



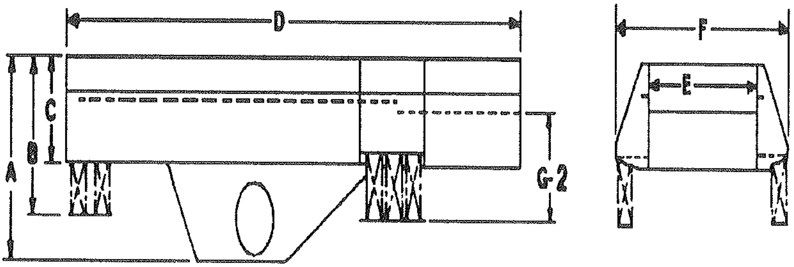
DIMENSION	SIZE (Length x Width) 45" X 14'	45" X 16'	45" X 18'	45" X 20'	45" x 22'	45" X 24'
A	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"
B	3'-4"	3'-4"	3'-4"	3'-4"	3'-4"	3'-4"
C	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"
D	14'-0"	16'-0"	18'-0"	20'-0"	22'-0"	24'-0"
E	3'-9"	3'-9"	3'-9"	3'-9"	3'-9"	3'-9"
F	6'-2"	6'-2"	6'-2"	6'-2"	6'-2"	6'-2"
G-2	1'-11"	1'-11"	1'-11"	1'-11"	1'-11"	1'-11"

DIMENSION	SIZE (Length x Width) 51" X 14'	51" X 16'	51" X 18'	51" X 20'	51" x 22'	51" X 24'
A	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"
B	3'-4"	3'-4"	3'-4"	3'-4"	3'-4"	3'-4"
C	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"
D	14'-0"	16'-0"	18'-0"	20'-0"	22'-0"	24'-0"
E	4'-3"	4'-3"	4'-3"	4'-3"	4'-3"	4'-3"
F	6'-8"	6'-8"	6'-8"	6'-8"	6'-8"	6'-8"
G-2	1'-11"	1'-11"	1'-11"	1'-11"	1'-11"	1'-11"

DIMENSION	SIZE (Length x Width) 57" X 16'	57" X 18'	57" X 20'	57" X 22'	57" x 24'	62" X 16'
A	4'-2"	4'-2"	4'-2"	4'-8"	4'-8"	5'-5"
B	3'-4"	3'-4"	3'-4"	3'-4"	3'-4"	4'-2"
C	2'-2"	2'-2"	2'-2"	2'-2"	2'-2"	3'-0"
D	16'-0"	18'-0"	20'-0"	22'-0"	24'-0"	16'-0"
E	4'-9"	4'-9"	4'-9"	4'-8"	4'-8"	5'-2"
F	7'-2"	7'-2"	7'-2"	7'-4"	7'-4"	7'-10"
G-2	1'-11"	1'-11"	1'-11"	1'-11"	1'-11"	2'-7"

NORDBERG VIBRATING GRIZZLY FEEDER WITH TWO GRIZZLY SECTION

Dimensions (Continued)



DIMENSION	SIZE (Length x Width) 62" X 18'	62" X 20'	62" X 22'	62" X 24'	68" X 16'	68" X 18'
A	5'-5"	5'-5"	6'-1"	6'-1"	5'-5"	5'-5"
B	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"
C	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
D	18'-0"	20'-0"	22'-0"	24'-0"	16'-0"	18'-0"
E	5'-2"	5'-2"	5'-2"	5'-2"	5'-8"	5'-8"
F	7'-10"	7'-10"	7'-10"	7'-10"	8'-4"	8'-4"
G-2	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"

DIMENSION	SIZE (Length x Width) 68" X 20'	68" X 22'	68" X 24'	74" X 16'	74" x 18'	74" X 20'
A	5'-5"	6'-1"	6'-1"	5'-5"	5'-5"	6'-1"
B	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"	4'-2"
C	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"	3'-0"
D	20'-0"	22'-0"	24'-0"	16'-0"	18'-0"	20'-0"
E	5'-8"	5'-8"	5'-8"	6'-2"	6'-2"	6'-2"
F	8'-4"	8'-4"	8'-4"	8'-10"	8'-10"	8'-10"
G-2	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"	2'-7"

DIMENSIÓN	SIZE (Length x Width) 74" X 22'	74" X 24'	86" X 18'	86" X 20'		
A	6'-1"	6'-1"	6'-1"	6'-1"		
B	4'-2"	4'-2"	4'-2"	4'-2"		
C	3'-0"	3'-0"	3'-0"	3'-0"		
D	20'-0"	24'-0"	18'-0"	20'-0"		
E	6'-2"	6'-2"	7'-2"	7'-2"		
F	8'-10"	8'-10"	9'-10"	9'-10"		
G-2	2'-7"	2'-7"	2'-7"	2'-7"		

APRON FEEDERS

Capacities

Pan Speed FPM	Pan Width (Inches)															
	18		24		30		36		42		48		60		72	
	YD^3	TPH	YD^3	TPH	YD^3	TPH	YD^3	TPH	YD^3	TPH	YD^3	TPH	YD^3	TPH	YD^3	TPH
10	20	27	36	48	56	75	80	108	109	147	142	192	222	300	320	432
15	30	40	53	72	83	112	120	162	163	220	213	288	333	450	480	648
20	40	54	71	96	111	150	160	216	218	294	284	384	444	600	640	864
25	50	67	89	120	139	187	200	270	272	367	356	480	556	750	800	1080
30	60	81	107	144	167	225	240	324	327	441	427	576	667	900	960	1296
35	70	94	124	168	194	262	280	378	381	514	498	672				
40	80	108	142	192	222	300	320	432	436	488	569	768				

Pan Speed MPM	Pan Width (Inches)															
	18		24		30		36		42		48		60		72	
	M^3	MTH	M^3	MTH	M^3	MTH	M^3	MTH	M^3	MTH	M^3	MTH	M^3	MTH	M^3	MTH
3	15	24	27	43	42	68	61	97	83	133	108	174	169	272	244	391
4.5	22	36	40	65	63	101	91	146	124	199	162	261	254	408	366	587
6	30	48	54	87	84	136	122	195	166	266	215	348	339	544	488	783
7.6	38	60	67	108	106	169	152	244	207	332	271	435	424	680	611	979
9	45	73	81	130	127	204	183	293	249	399	326	522	509	816	733	1175
10.6	53	85	94	152	148	237	213	342	291	466	380	609				
12	61	97	108	174	169	272	244	391	333	533	434	696				

Above capacities based on material weighing 100 lbs. per cu. ft. and the depth of material on the pan as one-half the width of the pans. For materials of different weights, the capacities will increase or decrease proportionally.

Cu. Yds. Per Hr. = $W \times W \times S \times 0.88 = 0.88W^3S$

W = Width of Feeder in Feet   S = Pan Speed in Feet Per Minute

A feeding factor of .8 has been introduced to compensate for voids, resistance to flow, etc. This factor, too, will vary with the type of material and its condition when fed.

The following formula can be used to calculate the approximate capacity in cubic yards of a feeder of given width where the feeding factor is determined to be other than .8:

Cu. Yds. Per Hr. = 2.22(dxwxsxf); where:

d = depth of load on feeder, in feet;

w = width of feeder, in feet;

s = rate of pan travel, in feet per minute;

f = feeding factor.

To convert cu. yds. to tons, multiply cu. yds. by 1.35.

RECIPROCATING PLATE FEEDER CAPACITY

For Feeders Supplied on Nordberg Conveyors

Size for Conveyor Width	18" (457mm)	24" (610mm)	30" (762mm)	36" (914mm)
Capacity TPH (MTP)	160 (145)	240 (217)	360 (326)	440 (399)
HP	5	5	5	7.5

Capacity based on 64 RPM and maximum 8" stroke, 100 lbs. per cubic foot material, 25% voids.

SYNTRON FEEDER CAPACITIES

Model	Standard Trough Width x Length (mm)	Maximum Capacity TPH	Maximum Capacity MTH
F330	24" x 48" (610 x 1219)	180	163
F380	30" x 48" (762 x 1219)	270	245
F440	36" x 54" (914 x 1372)	350	318
F450	48" x 60" (1219 x 1524)	450	408
F480	48" x 72" (1219 x 1829)	700	635
F560	54" x 84" (1371 x 2134)	900	816
F660	60" x 90" (1524 x 2286)	1250	1134
F88	72" x 96" (1828 x 2438)	1600	1452

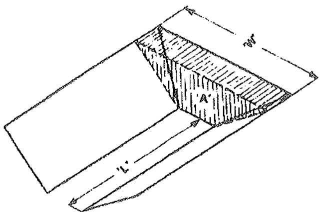
Capacities are based on standard troughs sloped 10° downgrade, and below deck magnet when installed with proper skirtboards based on dry sand weighing 100 lbs. per cubic foot.

Capacities may be reduced because of drive location which restricts material depth.

FEEDER HOPPER VOLUME CHART

Hopper Width 'W'		8 Ft. (2.4M)		10 Ft. (3M)		12 Ft. (3.6M)		14 Ft. (4.2M)		16 Ft. (4.8M)	
Feeder Factors Inches (mm)		'A'	'B'	'A'	'B'	'A'	'B'	'A'	'B'	'A'	'B'
Apron Feeders	18" (457)	.54	.57	1.11	.91	2.00	1.31	3.26	1.79	4.95	2.35
	24" (610)	.50	.56	1.03	.89	1.87	1.30	3.08	1.78	4.71	2.33
	30" (762)	.43	.53	.94	.87	1.75	1.28	2.92	1.76	4.51	2.31
	36" (914)	.37	.51	.85	.84	1.63	1.25	2.75	1.73	4.30	2.29
	42" (1066)	.31	.48	.76	.81	1.50	1.22	2.59	1.70	4.07	2.26
	48" (1219)	.26	.44	.67	.78	1.37	1.19	2.41	1.67	3.86	2.22
	60" (1524)			.50	.69	1.11	1.10	2.06	1.58	3.40	2.14
	72" (1829)			.34	.59	.87	1.00	1.71	1.48	2.94	2.04
Vibrating Grizzly Feeders	30" (762)	.43	.53	.94	.87	1.75	1.28	2.92	1.76	4.51	2.31
	36" (914)	.37	.51	.85	.84	1.63	1.25	2.75	1.73	4.30	2.29
	44" (1117)	.29	.47	.73	.80	1.46	1.21	2.52	1.69	4.00	2.25
	54" (1371)			.59	.74	1.24	1.15	2.23	1.63	3.62	2.18

Factors based on water level full hopper and no roll-over section.



Example: 42" x 16'-0" apron feeder with 14 ft. wide hopper.

Volume In Cubic Yards = A + (B X L)
= 2.59 + (1.70 x 16)
= 2.59 + (27.20)
= 29.79 Cubic Yards

Nordberg®

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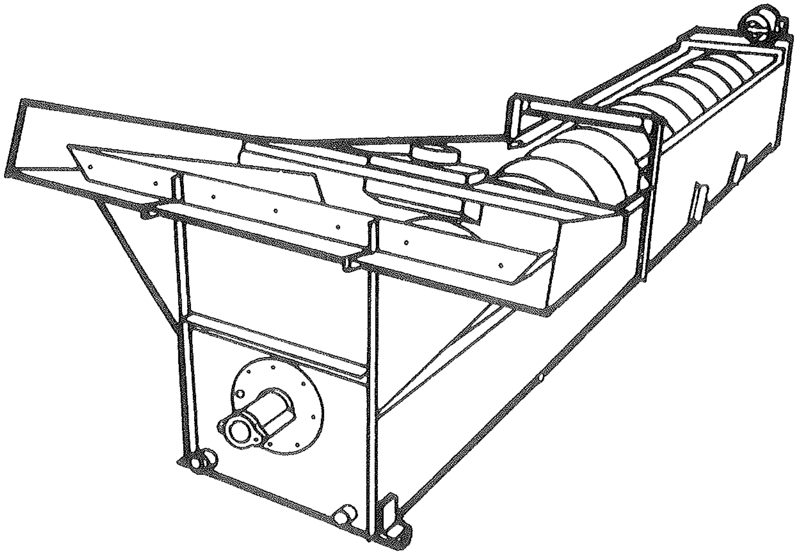
Washing and Classifying



SPECIFICATIONS - SINGLE SCREW
FINE MATERIAL WASHER - CLASSIFIER - DEHYDRATOR

Screw Diameter	20"	508mm	24"	618mm	30"	762mm	36"	914mm	44"	1117mm
Tub Length - Feet	22'	6706mm	22'	6706mm	25'	7620mm	25'	7620mm	32'	9754mm
*Capacity - Tons Per Hour	30	27 m/tons	530	45 m/tons	75	68 m/tons	100	90 m/tons	175	158 m/tons
Maximum Material Size	3/8"	9mm	3/8"	9mm	3/8"	9mm	3/8"	9mm	3/8"	9mm
**H.P. (Normal) Req. (Electric)	5		7-1/2		15		15		25	
Water Req. (G.P.M. at 25 P.S.I.)	30-195		30-235		40-275		40-360		60-740	
Water Req. (L.P.M. at 1.7 BARS)	113-738		113-889		151-1040		115-1362		227-2800	
Screw Speed - R.P.M. (Normal)	38		32		26		21		17	
Weight of Washer - Pounds	5500	2491 kgs.	6100	2763 kgs.	9000	4077 kgs.	10,400	4711 kgs.	17,900	8108 kgs.
Loaded Weight - Pounds	16,850	7633 kgs.	17,850	8086 kgs.	24,900	11279 kgs.	29,800	13499 kgs.	69,900	31664 kgs.
Screw Diameter	48"	1219mm	54"	1371mm	66"	1676mm	72"	1828mm		
Tub Length - Feet	38'	11582mm	34'	10363mm	35'	10668mm	38'	11582mm		
*Capacity - Tons Per Hour	208	188 m/tons	275	249 m/tons	400	362 m/tons	475	430 m/tons		
Maximum Material Size	3/8"	9mm	3/8"	9mm	3/8"	9mm	3/8"	9mm		
**H.P. (Normal) Req. (Electric)	30		40		60		75			
Water Req. (G.P.M. at 25 P.S.I.)	60-820		60-950		60-1150		60-1250			
Water Req. (L.P.M. at 1.7 BARS)	227-3100		227-3595		227-4352		227-4731			
Screw Speed - R.P.M. (Normal)	17		14		11		11			
Weight of Washer - Pounds	17,800	8074 kgs.	27,500	12457 kgs.	40,200	18210 kgs.	47,750	21630 kgs.		
Loaded Weight - Pounds	85,400	38737 kgs.	86,500	39184 kgs.	131,000	59343 kgs.	173,270	78491 kgs.		

SPECIFICATIONS - DOUBLE SCREW
FINE MATERIAL WASHER - CLASSIFIER - DEHYDRATOR

Screw Diameter	36"	914mm	44"	1117mm	54"	1371mm	66"	1676mm	72"	1828mm
Tub Length - Feet	25'	7620mm	32'	9754mm	34'	10363mm	35'	10668mm	38'	11582mm
*Capacity - Tons Per Hour	200	181 m/tons	350	317 m/tons	550	498 m/tons	800	725 m/tons	950	861 m/tons
Maximum Material Size	3/8"	9mm	3/8"	9mm	3/8"	9mm	3/8"	9mm	3/8"	9mm
**H.P. (Normal) Req. (Electric)	30		50		80,		120,		150,	
Water Req. (G.P.M. at 25 P.S.I.)	105-620		125-1400		125-1700		125-2050		125-2500	
Water Req. (L.P.M. at 1.7 BARS)	397-2346		473-5299		473-6434		473-7759		473-9462	
Screw Speed - R.P.M. (Normal)	21		17		14		11		11	
Weight of Washer - Pounds	17,650	7995 kgs.	34,400	15583 kgs.	55,200	25005 kgs.	77,500	35107 kgs.	99,950	45277 kgs.
Loaded Weight - Pounds	54,150	24529 kgs.	123,200	55809 kgs.	164,200	74382 kgs.	249,500	113023 kgs.	347,400	157372 kgs.

* Capacity ratings are stockpiled materials and are to be used as a guide only.

They are based on average amount of fines in material feeds. Reduced screw speed and capacity require less horsepower.

1 Two Motors and separate reducers and drives.

** Horsepower requirements listed are for electric motors. When replacing with gasoline or diesel engine, multiply the electric motor horsepower by 1-1/2 and select an engine with a corresponding continuous horsepower -- if continuous horsepower is not given, use 80% of maximum horsepower given for the engine.

SPECIFICATIONS - SINGLE SCREW COARSE MATERIAL WASHER - DEWATERER

Screw Dia. - In. (mm)	22" (558)	22" (558)	24" (609)	24" (609)	30" (762)	36" (914)	44" (1117)
Tub Length - Ft. (mm)	15' (4572)	18' (5486)	15' (4572)	18' (5486)	18' (5486)	18' (5486)	20' (6096)
Capacity - Tons Per Hour (m/tons)	45-55 (40-49)	45-55 (40-49)	60-75 (54-68)	60-75 (54-68)	100-125 (90-113)	150-175 (136-158)	200-250 (181-226)
Max Material Size - In. (mm)	2" (51)	2" (51)	2" (51)	2" (51)	2-1/2" (63)	2-1/2" (63)	3" (76)
*Horsepower Req. (Electric)	10	15	15	15	20	30	40
Water Req.(G.P.M. at 25 P.S.I.) Water Req.(L.P.M. at 1.7 Bars)	250-350 946-1324	250-530 946-1324	300-400 1135-1514	300-400 1135-1514	350-450 1324-1703	400-600 1514-2271	500-750 1892-2838
Screw Speed - R.P.M.	40	40	40	40	35	32	26
Weight of Washer - Lbs. (kgs.)	5,250 (2378)	6,050 (2740)	6,150 (2785)	7,100 (3216)	9,450 (4280)	12,150 (5503)	20,600 (9331)
Loaded Weight - Lbs. (Kgs.)	9,550 (4326)	10,650 (4824)	13,850 (6274)	15,350 (6953)	22,250 (10079)	30,350 (13748)	36,500 (16534)

SPECIFICATIONS - DOUBLE SCREW COARSE MATERIAL WASHER - DEWATERER

Screw Dia. - In. (mm)	30" (762)	36" (914)	44" (1117)
Tub Length - Ft. (mm)	18' (5486)	18' (5486)	20' (6096)
Capacity - Tons Per Hour (m/tons)	200-250 (181-226)	300-350 (272-317)	400-500 (362-453)
Max Material Size - In. (mm)	2-1/2" (63)	2-1/2" (63)	3" (76)
*Horsepower Req. (Electric)	40	50	75
Water Req.(G.P.M. at 25 P.S.I.) Water Req.(L.P.M. at 1.7 Bars)	600-800 2271-3028	700-900 2649-3406	900-1100 3406-4165
Screw Speed - R.P.M.	35	32	26
Weight of Washer - Lbs. (kgs.)	17,150 (7768)	22,000 (9966)	34,400 (15583)
Loaded Weight - Lbs. (Kgs.)	35,350 (16013)	49,800 (22559)	69,000 (31257)

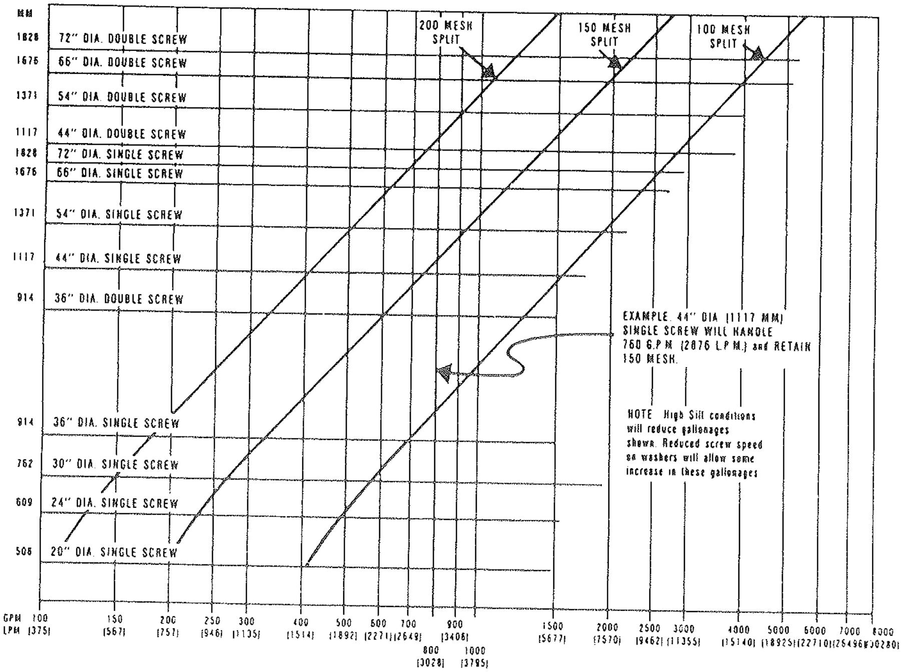
*Power requirements are based on electric motors and on handling gravel. Ample horsepower is provided to handle the maximum sized material set fourth in the specifications. If the water is handling a high percentage of this maximum sized material, or if the water is handling crushed stone or ore, the capacity of the unit will be reduced from that set forth in specifications. Installation of paddles in place of screw flights will also reduce capacity slightly and if more than six sets of paddles are employed on each conveyor shaft, the larger required motors will be employed. When replacing electric motor with gasoline or diesel engine, multiply the electric motor horsepower by 1-1/2 and select an engine with a corresponding continuous horsepower - if continuous horsepower is not given, use 80% of maximum horsepower given for the engine size.

Identification of Material	Percent Passing 50 Mesh	Screw Speed Reduction % of Normal Catalog Rated Speed	% of Catalog Rated Tonnage	Resultant Peripheral Catalog Rated Speed
#1	15% or Less	100%	100%	*200Ft./Min.
#2	20% or Less	75%	75%	150Ft./Min.
#3	30% or Less	50%	50%	100Ft./Min.
#4	50% or Less	25%	25%	50Ft./Min.
#5	85% or Less	16%	16%	32Ft./Min.

* 200 Ft./Min. Peripheral Speed Equal to 100% Catalog Rated Screw Speed On All Size FM Units.

GALLONAGE CHART FOR EAGLE FINE MATERIAL UNITS

Maximum Amount Slurry at Low Silt Content Tub Will Handle for Various Retention of Fines



The above chart for Eagle Fine Material Units indicates the maximum water fed in relation to the mesh of material retained for various units. Example: Select a diameter, either single or double screw, along the vertical edges of the chart; use the horizontal line beneath the diameter selected to enter the chart. Follow this horizontal line across the chart until it intersects a diagonal line which sets forth the desired mesh of the retained product. Drop a vertical line from this intersection and read the water capacity in gallons per minute. (Liters per minute).

EAGLE WATER SCALPING CLASSIFYING TANK CAPACITIES

Scalping tank sizes are determined by two figures:

Dilution factor: 100 G.P.M. is required to dilute each T.P.H. of silt (-200m) of incoming feed.

Example: Feed 300 T.P.H. sand with 6% or 18 T.P.H. of silt. 18 x 100 = 1800 G.P.M. required to dilute silt. Saving material on 150 m, use 24' x 10' Single Tank.

Water Required for screening: 4 to 6 G.P.M. of water per T.P.H. of feed is required to screen material before a scalping tank.

Example: Feed 300 T.P.H. of crushed stone to a wet screen. Feed contains -200m. 6 G.P.M. x 300 T.P.H. = 1800 G.P.M. required.

Saving material on -200m, use 48'x12' Single Tank.

Note: Final selection depends on feed analysis and product requirements.

Single Tank Length x Width Feet (Meters)	Maximum Gallons (Liters) Per Minute of Slurry at Low Silt Content Allowable in Saving Fine Sand Retained on		
	100 Mesh	150 Mesh	200 Mesh
20' x 8' (6 x 2.4)	2300 (8705)	1200 (4542)	700 (2649)
24' x 8' (7.2 x 2.4)	2800 (10598)	1400 (5299)	800 (3028)
28' x 8' (8.4 x 2.4)	3200 (12112)	1600 (6056)	900 (3406)
24' x 10' (7.2 x 3)	3500 (13247)	1800 (6813)	950 (3593)
28' x 10' (8.4 x 3)	4100 (15518)	2100 (7948)	1100 (4163)
32' x 10' (9.6 x 3)	4700 (17789)	2400 (9084)	1250 (4731)
36' x 10' (10.8 x 3)	5300 (20060)	2700 (10219)	1400 (5299)
40' x 10' (12 x 3)	5900 (22331)	3000 (11355)	1550 (5866)
48' x 12' (14.4 x 3.6)	8100 (30658)	4200 (15897)	2150 (8137)

Double Tank Length x Width Feet (Meters)	Maximum Gallons (Liters) Per Minute of Slurry at Low Silt Content Allowable in Saving Fine Sand Retained on		
	100 Mesh	150 Mesh	200 Mesh
32' x 10' (9.6 x 3)	9400 (35579)	4800 (18168)	2500 (9462)
36' x 10' (10.8 x 3)	10600 (40121)	5400 (20439)	2800 (10598)
40' x 10' (12 x 3)	11800 (44663)	6000 (22710)	3100 (11733)
48' x 12' (14.4 x 3.6)	16200 (61317)	8400 (31794)	4300 (16275)

DREDGE PUMP

17 ft./sec.		
Size (I.D)	GPM Slurry	TPH
4	670	38
6	1,500	85
8	2,700	154
10	4,200	239
12	6,000	341
14	8,200	467
16	10,100	609
18	13,500	768
20	15,270	869

20% Solids by wt. @ 100 lbs./cu. ft. =
4 TPH Water per 1 TPH Solids
17.56 GPM Slurry / 1 TPH Solids

This information can be used as a guide in preliminary selection of material handling components. For plants charged by dredge pumps. Proper selection of sand processing components is in part controlled by maximum amount of water in the slurry.

Prior to final selection of machinery complete information must be assimilated so sound judgement can be exercised.

NOTES

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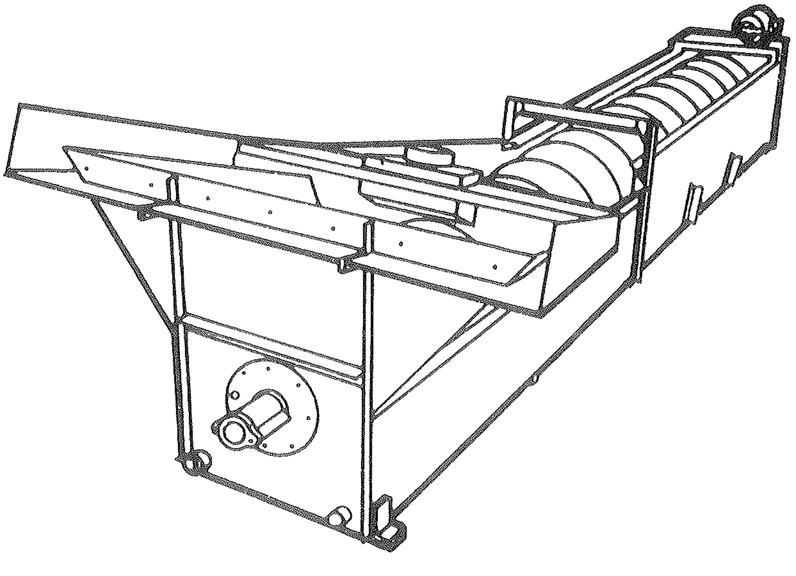
McLANAHAN 15-8

Washing and Classifying



SAND CLASSIFYING TANKS

Sand Classifying Tanks have a variety of functions but are most commonly known for their ability to produce specification products from non-specification feed materials. Sand Classifying Tanks provide three basic functions,

(1) They can be used to scalp off large quantities of water which are associated with raw feed material as produced by a pumping or dredging operation.

(2) They can be used to separate a single feed material to various grades of sand product such as concrete, mason and asphalt.

(3) They can be used to bleed off excessive amounts of various grain sizes which cause the feed material to be out of specification.

SAND TANK OPERATION

The method of classification employed by the Sand Classifying Tank is based on the different settling rates of various grain sizes of sand. As water and material enter the feed end, the coarser grains settle first, while finer particles in successive sizes settle toward the opposite end of the Tank (see figure 1). The excess water, excess fines and silt type material will report to settling ponds or clarifiers as they overflow the adjustable weir on the overflow launder.

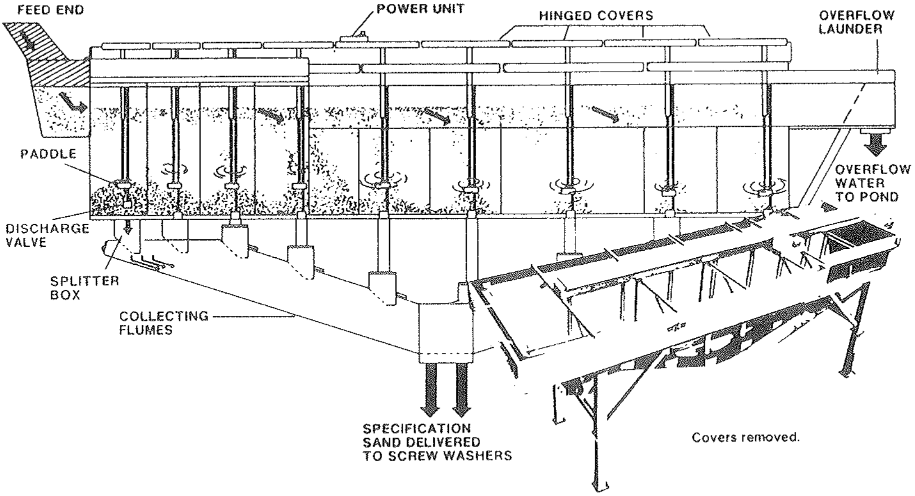


Figure 1. Operation of the Sand Classifying Tank

SAND TANK OPERATION
(continued)

There are a series of valve stations located at the bottom of the Tank at pre-determined spacing along the length which serve as discharge points for the accumulated sand particles in that area. At each of these valve stations a stall type torque motor is employed to sense the accumulation of sand particles to an adjustable and pre-determined height above the bottom of the Sand Classifying Tank.

At the top of the Tank is a series of hydraulic control mechanisms which operate the discharge valves at the bottom. A separate hydraulic control is provided for each valve station. (See figure 2). Two rods extend from each control unit; one to a discharge valve, the other to a four blade paddle above the Tank bottom. (See figure 3). The rod to the paddle is driven by an electric torque motor. When material settles to the bottom of the Tank it builds up to the paddle. This material stalls the paddle which in turn causes the torque motor to stall, thereby closing an electrical circuit operating the solenoid valve which directs pressure through the hydraulic cylinder to the rod controlling the discharge valve. This opens the valve at the bottom of the Tank which discharges the material which has accumulated at that station.

Once the sand has cleared the paddle, the torque motor will start the paddle rotating again, energizing the electric solenoid in the opposite direction which in turn reverses the flow of the hydraulic system, causing the discharge valve to close and the process starts over once again.

At this point it should be pointed out that McLanahan Corporation manufactures Automatic (Pro-Control and Semi-Pro Control) and Manual Sand Classifying Tanks. Our manual control Sand Classifying Tank utilizes splitter boxes for producing products required. (See figure 4). These splitter boxes are located between the bottom of the Sand Classifying Tank and the top of the collecting flumes. Sand discharged through a valve station in the bottom of the Tank falls into a splitter box which delivers the proper amount of material to each section of the collecting flume.

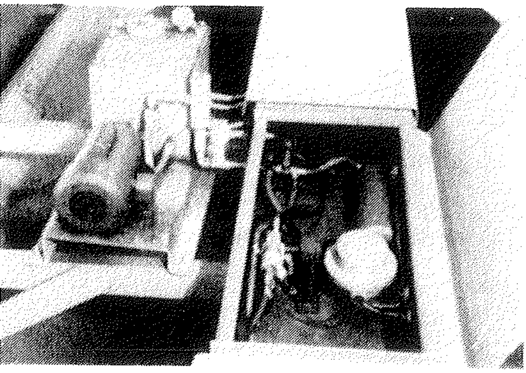


FIGURE 2
The McLanahan Sand tank has a control unit for each valve station located beneath a hinged cover plate which forms the walkway at the top of the tank. At the center of the tank is located the hydraulic pump which provides the required hydraulic fluid at the correct operating pressure, motor, hydraulic pressure gauge, reservoir and reservoir filter. A nitrogen gas accumulator provides the required hydraulic pressure to retain the valve in closed position in the event of a power failure or when the tank is shut off at the end of an operating shift. This accumulator automatically recharges when electric power is restored.

SAND TANK OPERATION
(continued)

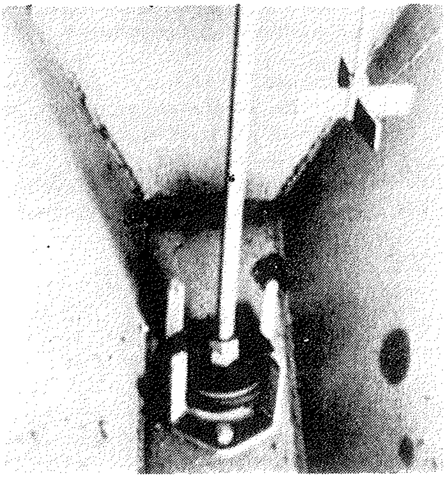


FIGURE 3
Design of the internal tank valve eliminates sand packing around the opening, this being particularly beneficial at the fine end. The valves open upward inside tank, loosening settled material to assure free flow of sand without discharging water. Components include adjustable valve rod, rubber-backed steel valve disc, renewable valve guides and renewable wearing sleeve in the tank bottom. The 4-blade paddle has a neoprene protective coating.

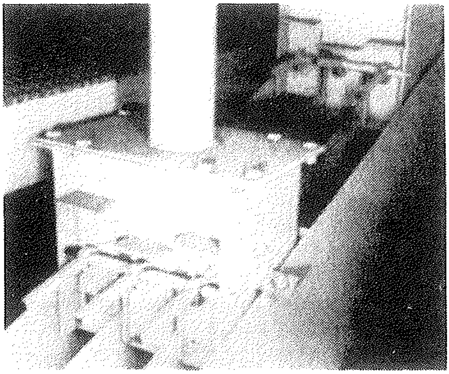


FIGURE 4
Splitter boxes are located at the bottom of the tank at each of the valve stations. Adjustment of the slide gates permits the operator to vary the amount of material discharged to each of the collecting flumes. By this means, the product gradation may be changed to meet a different specification or adjustment may be made in order to meet varying feed conditions while remaining in specification.

SAND TANK OPERATION

(continued)

McLanahan Corporation manufactures an Automatic Sand Classifying Tank. In this design unit it should be noted that there is more than one discharge opening at each valve station. If the Sand tank is designed for producing two specification products, then three discharge openings would be found at each valve station, two for handling each of the specification products and one for handling any excess material accumulated at that station (See figure 5).

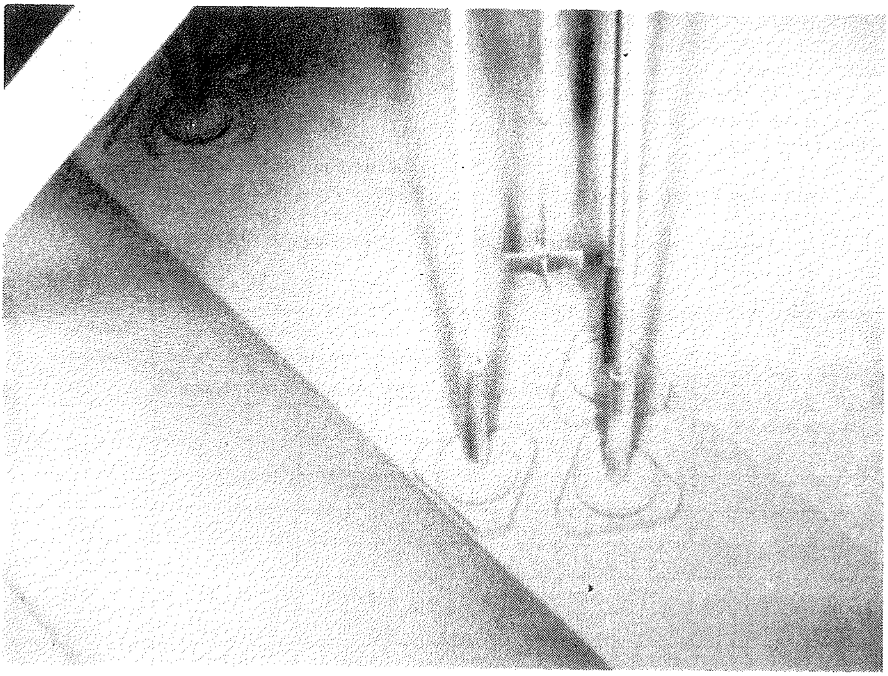


Figure 5. Valve Station for Pro-Control Automatic Sand Classifying Tank

Once the material has accumulated at any particular valve station to a point where the paddle driven by the torque motor has stalled, the programmed control system takes over and will direct the sand particles to the particular product requiring the gradation produced by that particular valve station by opening the correct valve.

The McLanahan Pro-Control Automatic Sand Classifying Tank is discussed in greater detail later in this section.

EQUIPMENT SIZING AND SELECTION

When sizing and selecting Sand Classifying Tanks there are a number of items which must be taken into consideration. First of all, it is necessary to determine the screen analysis of the feed material being sent to the Sand Classifying Tank. It is also necessary to know the screen analysis of the desired products. In addition to knowing what capacity the Tank must be required to handle, it is also essential to know how many gallons of water are available and will be sent to the Sand Tank with the feed material. In summary, we are providing the following check list of data required when sizing and selecting a Sand Classifying Tank.

- Determine screen analysis of feed material.
- Determine screen analysis of desired product or products.
- Determine capacity in terms of tons per hour which the Tank must be capable of handling.
- Determine water availability in terms of G.P.M.

Once the above information has been accumulated, we can then refer to our chart specifying the maximum water capacities of McLanahan Sand Classifying Tanks. (See figure 6). When using this chart it is necessary to realize that we normally recommend that 10 G.P.M. of water be fed with each T.P.H. dry weight of sand for proper distribution of sand through the Tank. This amount of water must be used in order to spread the grain sizes along the bottom of the Tank for adequate separation in order to obtain classification.

		Max. G.P.M. of water allowable in saving fine sand retained on ...			Maximum Capacity*
	Length	100 Mesh	150 Mesh	200 Mesh	TPH
10' WIDE SERIES	24'	3,150	1,575	1,000	160
	28'	3,600	1,800	1,015	180
	32'	4,160	2,135	1,125	210
	40'	5,160	2,645	1,500	265
11' WIDE SERIES	32'	4,660	2,380	1,240	240
	40	5,845	2,970	1,535	300
12' WIDE SERIES	40'	6,475	3,295	1,700	330
	48'	7,775	3,890	1,945	390

Figure 6. Maximum Water Capacities and Solids Capacities of McLanahan Sand Classifying Tanks.

*Capacity given in S.T.P.H. for material weighing 100 PCF, bulk density.

Keeping in mind the requirement of utilizing 10 G.P.M. of water for each ton per hour dry weight of sand, we refer to figure 6 which provides the maximum water capabilities of our Sand Tanks. Using the column titled 150 mesh we can see how the gallonage figures relate to the solids capacity figures.

EQUIPMENT SIZING AND SELECTION
(continued)

As an example, if a sand producer has an application which involves the handling of 150 T.P.H. dry weight of sand we would select a 10' x 24' Sand Classifying Tank since its maximum rated capacity would be 160 T.P.H. dry weight. We would further make the recommendation that 1,500 G.P.M. of water be used for classifying this 150 T.P.H. of sand.

If however this same customer is operating a dredge type plant and is sending more than 1,500 G.P.M. of water to the Tank along with his 150 T.P.H. of sand, then it may be necessary to select a Tank capable of handling the higher water volume rather than the 150 T.P.H. of dry solids.

Still another case might arise where this same customer does not have sufficient water for particle distribution and classification of sand. In this case, it may be necessary to utilize rising current classification which is an optional feature on all McLanahan Sand Classifying Tanks. (See figure 7). Rising current classification permits the introduction of fresh or recirculated water which is admitted under pressure beneath settling material at the first, second, third or fourth valve stations. This rising current classification system can also be used for providing more exact separation of coarse from fine sand.

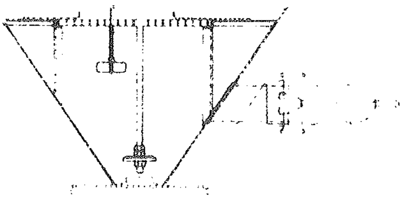


Figure 7. Rising Current Classification System for McLanahan Sand Classifying Tanks.

Once the Sand Classifying Tank has been placed in operation it is necessary for the operator to obtain and record screen analyses of the products of each valve station. When using this information in conjunction with the screen analysis data collected from the dewatered Sand Tank products, the operator can fine tune the Sand Classifying Tank to produce products meeting specification.

As an example, if it is determined that the dewatered products of a Sand Classifying Tank contains too much 16 mesh material, the operator can refer back to his recorded screen analyses of each valve station to determine which valve station is producing the majority of the 16 mesh size fraction. When this is determined the operator can then make adjustments at that particular valve station to correct the amount of 16 mesh material being discharged as product. On the manual Sand Classifying Tank this adjustment would consist of repositioning the splitter box gates. On the Pro-Control Tank the adjustment would amount to utilizing the programmable controller to readjust the amount of time which the product valve is staying open.

McLANAHAN PRO-CONTROL AND SEMI-PRO CONTROL AUTOMATIC SAND CLASSIFYING TANK

The McLanahan Pro-Control and Semi-Pro-Control Sand Classifying Tanks utilize the same settling rate principle as the manual design Tank. However, once material has accumulated at any particular valve station to the point where the paddle driven by the torque motor has stalled, the programmed control system takes over and will direct the sand particles to the particular product requiring the gradation produced at any valve within the Tank.

The McLanahan Pro-Control Automatic Sand Classifying Tank incorporates a solid state programmable controller system (see Fig. 8) that enables an operator to record minimum and maximum time valves for each valve station so that when all the valve stations have met their minimum time a specified product will be achieved in spite of frequent changes within a deposit. Having both a minimum and maximum time valve will provide the maximum production consistent with the feed gradation.

The McLanahan Semi-Pro-Control Semi-Automatic Sand Classifying Tank is used when the feed gradation is not as inconsistent. This control system (see Fig. 8A) allows the operator to adjust each valve station independently of the others. The valve station adjustments are made conveniently and remotely by the operator.

Each Tank is capable of producing a maximum of three controlled products and one non-spec product at any one time. In most instances one of two controlled products will meet the requirements of a particular sand plant and most Tanks are manufactured with two controlled products and one non-spec product.

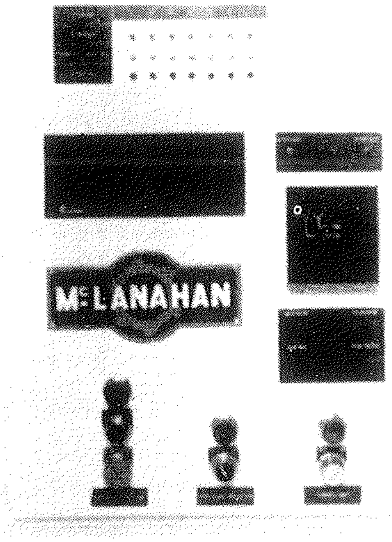


Figure 8. Pro-Control

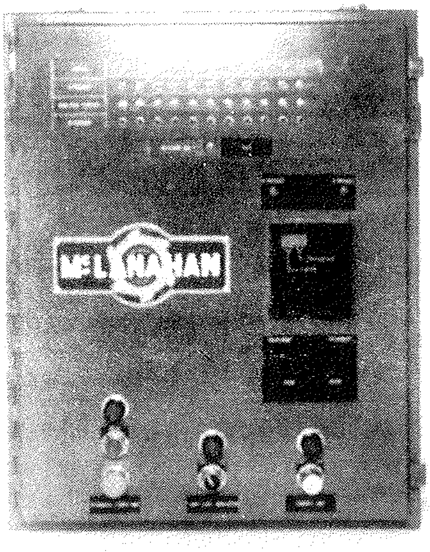


Figure 8A. Semi-Pro-Control

SCREW WASHERS

McLanahan Screw Washers, also known as Dewatering Screws, have three basic functions,

(1) Dewater materials. Removes excess water so the product is suitable for stockpiling.

(2) Wash. Removes slimes, silts, clays and floats of vegetation in the overflow water after their liberation by scouring and abrasion.

(3) Classify. Eliminates excess fines from the end product using adjustable weir overflow and rising current control.

McLanahan designs and builds Single and Double Screw Washers for both fine and coarse materials. These units are used to process a wide range of materials including concrete sand, asphalt sand, mortar sand, mason sand, brick sand, limestone sand, slag, crushed aggregate and other materials.

FINE MATERIAL SCREW WASHERS

McLanahan Fine Material Screw Washers are primarily used to dewater, classify and wash - 3/8" sand. These machines are designed to accept feeds from Sand Classifying Tanks, Screens or other Fine Material Screw Washers and convey the sand from the pool and feed end of the washer box up the slope of the unit to the discharge end. As the material is conveyed beyond the pool area, it enters the dry deck section of the washer at which point the water begins to separate from the sand. The McLanahan extra long dry deck area provides maximum dewatering of fine sand. The curvature of the rotating screw flights conforms to the curved section of the washer box to efficiently convey, wash through tumbling of sand particles, and direct the water draining from the sand to the opposite side of the washer box where a drainage channel is designed for quick removal of water from the dry deck area.

Water manifolds and adjusting weirs in the large pool area at the feed end of the Screw Washer enable the operator to adjust the amount of fine sand required in the end product. The classification of fines in this manner may be sufficient to meet product specifications without prior classification in a Sand Classifying Tank.

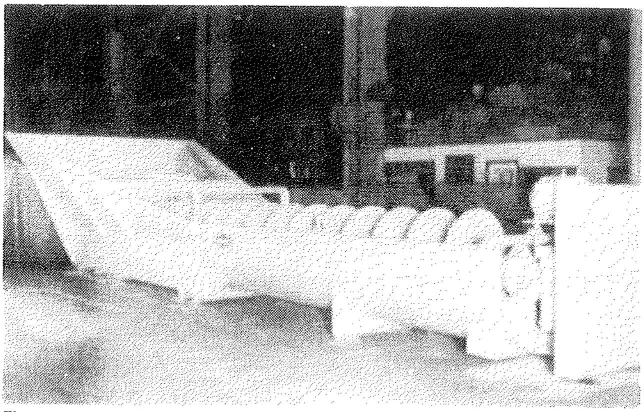


Figure 9. McLanahan Fine Material Single Screw Washer

FINE MATERIAL SCREW WASHERS
(continued)

The sizing and selection of a Fine Material Screw Washer is based upon the application information shown below,

- Type of material
- Feed gradation
- Desired product specification
- Capacity required
- Water volume in feed slurry

SINGLE SCREW WASHER

Screw Dia & Length	Capacity TPH	GPM Max. Water (100 Mesh Product)	GPM Max. Water (150 Mesh Product)	GPM Max. Water (200 Mesh Product)	Nominal Screw RPM	H.P. Elec. 1800 RPM	Wt. with Motor
20" x 25'	35	400	185	100	38	5	5,340
24" x 25'	50	450	205	110	32	10	6,140
30" x 25'	80	550	255	140	26	15	9,230
36" x 24'	105	680	310	170	21	15	9,050
36" x 27'	105	680	310	170	21	15	10,650
44" x 33'	175	1,240	605	320	17	25	20,780
54" x 35'	250	1,550	755	380	14	40	26,300
66" x 36'	400	2,300	1,120	640	11	60	42,350
72" x 38'	475	2,750	1,260	750	10	75	51,840

DOUBLE SCREW WASHER

Screw Dia & Length	Capacity TPH	GPM Max. Water (100 Mesh Product)	GPM Max. Water (150 Mesh Product)	GPM Max. Water (200 Mesh Product)	Nominal Screw RPM	H.P. Elec. 1800 RPM	Wt. with Motor
36" x 24'	210	1,000	510	250	21	2-15	16,370
36" x 27'	210	1,000	510	250	21	2-15	20,310
44" x 33'	350	2,250	1,090	540	17	2-25	30,730
54" x 35'	500	2,900	1,345	660	14	2-40	47,200
66" x 36'	800	4,000	1,985	1,100	11	2-60	78,500
72" x 38'	950	5,000	2,205	1,250	10	2-75	95,905

Figure 10. Capacity Charts and Data for McLanahan Fine Material Screw Washers

FINE MATERIAL SCREW WASHERS

(continued)

By referring to figure 11 one can see the relationship between screw speed and the allowable percentage of material passing the 50 mesh size in the product. This chart is used in conjunction with the product screen analysis of the screw to determine the correct speed of the screw shaft.

SCREW WASHER SPEED RELATIONSHIP TO % PASSING 50 MESH

15% or less	100% or less	200'/min.
20% or less	75% or less	150'/min.
30% or less	50% or less	100'/min.
50% or less	25% or less	50'/min.
85% or less	16% or less	32'/min.

Figure 11.

As an example, if a customer wants to process 100 T.P.H. of mason sand which contains 30% passing 50 mesh, the chart in figure 13 tells us that the screw shaft speed should be 50% of normal. With that in mind, we must select a 36" Double Screw Washer which would be capable of handling 105 T.P.H. when operating at 50% normal speed. This is due to the direct relationship between screw shaft speed and capacity.

Screw Washers are commonly used as dewatering screws following Sand Classifying Tanks. As a general rule of thumb, a Screw Classifier of proper length which is operating at the correct speed at the required slope of 18 degrees and has the correct water volume and pool density, will provide a dewatered concrete sand which contains approximately 12% to 15% moisture and a dewatered mason sand containing approximately 15% to 18% moisture.

McLanahan Screw Classifiers incorporate considerable flexibility for handling a variety of operating circumstances.

In addition to screw shaft speed being variable, the McLanahan Washer is also provided with adjustable overflow weirs which can affect the settling rates of sand particles by affecting the velocity of the water which is overflowing the pool area.

Rising current classification is also provided beneath the pool area for the purpose of controlling the density of the pool, thus affecting the settling rates of sand particles and water overflow characteristics. The upsurging of water through the pool area is designed to remove undesirable fines or excessive dirt and silt and vegetation and provide additional classification following a Sand Classifying Tank.

Screw Washers have also been used independent of Sand Classifying Tanks where they were required to remove excessive fines found in the feed material by the use of this rising current classification system or simply to dewater the product of a screen.

A baffle plate is also provided on the

FINE MATERIAL SCREW WASHERS
(continued)

McLanahan Fine Material Screw Washer to separate the turbulent water of the feed area from the calm pool classification section. This segregation of turbulent/calm water is imperative in order for the Screw Washer to operate as a classifier. The turbulent water section of the Screw Washer will force the sand particles into suspension, whereas the calm pool area will allow the coarser sand particles to settle out and the finer sand particles to float off with the overflow water.

SUBMERGED REAR BEARING

One area of utmost importance in the design of a Screw Washer is the submerged rear bearing. McLanahan Corporation offers two types, an Aqua-Lube bearing as illustrated in figure 12, and a Twin-Seal Pak roller bearing as illustrated in figure 13.

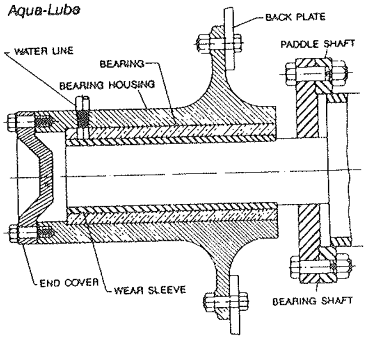


Figure 12. Aqua-Lube Feed End Bearing.

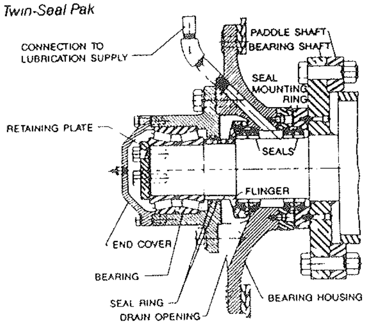


Figure 13. Twin-Seal Pak Roller Bearing at Feed End.

The Aqua-Lube bearing is standard on all Screw Washers and is water lubricated by a flow of 30 P.S.I. minimum of clean, clear water at a rate of 25 to 150 G.P.M.

The optional Twin-Seal Pak roller bearing is a very unique system which incorporates oil or grease lubricated Twin-Seals to keep water and even the smallest sand particles from reaching the bearing and bearing support shaft. The roller bearing itself is grease lubricated in all cases. Twin-Seal oil lubrication is utilized on 36" diameter and smaller Screw Washers. Twin-Seal grease lubrication is utilized on 44" diameter and larger Screw Washers. The head of water on the 44" and larger Screw Washers exerts too great a pressure for an oil lubricated seal to resist, therefore a stiffer grease lubrication is utilized.

Coarse Material Screw Washers

These machines are built primarily to process crushed stone and gravel, generally ranging from 3/8" to 4". They effectively remove light, loamy-type clays, dirt, crusher dust and coatings that cannot be removed by wet screening alone. They also can be used to take out floating vegetation and soft aggregates, although all vegetation and water-logged sticks will not be removed completely. In addition, these machines can be used as concrete reclaimers to liberate fine sand and cement from coarse aggregate.

In Coarse Material Screw Washers, paddles are used in conjunction with screw flights to provide additional scrubbing, scouring and agitation. (See Figures 14,15). The turbulent washing action, combined with rising current water introduced at the feed end, results in separation of the lighter fraction from the sound aggregate. The screw section then dewaters the washed aggregate for transfer on a belt conveyor to the stockpile.

Coarse Material Screw Washers are not recommended for removal of tough, plastic clay which normally requires a McLanahan Log Washer. The larger sized materials generally processed by McLanahan Scrubbers also are not suited for Screw Washers.

The sizing and selection of a Coarse Material Screw Washer is based upon the application information shown below,

- Type of material
- Desired capacity
- Maximum feed size
- Water volume in feed slurry

(It may be necessary to test the material at the McLanahan Application Research Lab facilities to determine the tenacity of the material).

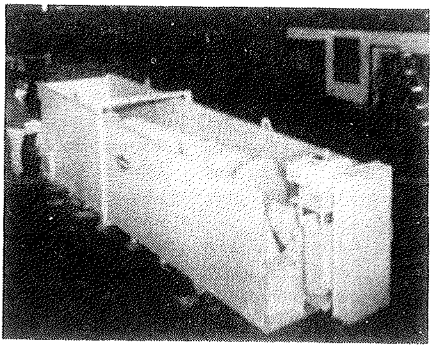


Figure 14. Overall View of McLanahan Coarse Material Single Screw Washer

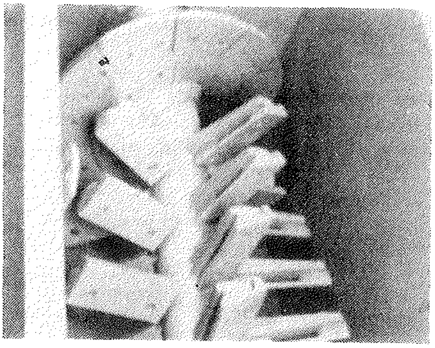


Figure 15. Close-up Showing Flight and Paddle Design.

COARSE MATERIAL SCREW WASHERS
(continued)

SINGLE SCREW WASHER

Screw Dia & Length	Capacity TPH	Normal Screw R.P.M.	Average H.P. 1800 R.P.M.	Maximum Feed Size	Water Required G.P.M.	Weight with Motor
20" x 15'	40	45	10	2"	200-300	4,400
20" x 20'	40	45	10	2"	200-300	5,835
24" x 15'	60	40	15	2"	300-400	5,550
24" x 20'	60	40	15	2"	300-400	6,450
30" x 15'	100	35	20	2-1/2"	350-450	9,000
30" x 20'	100	35	20	2-1/2"	350-450	10,105
36" x 15'	150	30	25	2-1/2"	400-600	10,050
36" x 20'	150	30	30	2-1/2"	400-600	11,000
44" x 20'	200	25	40	4"	600-800	15,250

DOUBLE SCREW WASHER

Screw Dia & Length	Capacity TPH	Normal Screw R.P.M.	Average H.P. 1800 R.P.M.	Maximum Feed Size	Water Required G.P.M.	Weight with Motor
24" x 20'	120	40	2-15	2"	450-650	11,510
30" x 20'	200	35	2-20	2-1/2"	600-800	14,915
36" x 20'	300	30	2-30	2-1/2"	700-900	17,300
44" x 20'	400	25	2-40	4"	800-1000	26,300

Figure 16. Capacity Chart and Data for McLanahan Coarse Material Screw Washers.

It is recommended that the -1/4" fraction be screened out ahead of the Coarse Material Screw Washer since the finer material will tend to cushion the washing action. This -1/4" fraction should only be fed to the Coarse Material Screw Washer when severe washing of fines is required. If these fines are fed to the Coarse Material Screw Washer, it may be necessary to capture the overflow water in order to save the -1/4" solids fraction for further processing. As a general rule of thumb, a Coarse Material Screw Washer will make a rough split at approximately 16 mesh.

Coarse Material Screw Washers do incorporate considerable flexibility and versatility for varied application requirements. In addition to providing the washer with an adjustable weir for water density control, rising current classification is also incorporated in the bottom of the box which provides an upsurging of water for floating off lighter fractions of deleterious material.

The number of paddles can also be increased from standard if the application warrants more aggressive agitation. With the increase of paddles the Screw Washer slope must be decreased in order to permit proper conveyance.

SUBMERGED REAR BEARING

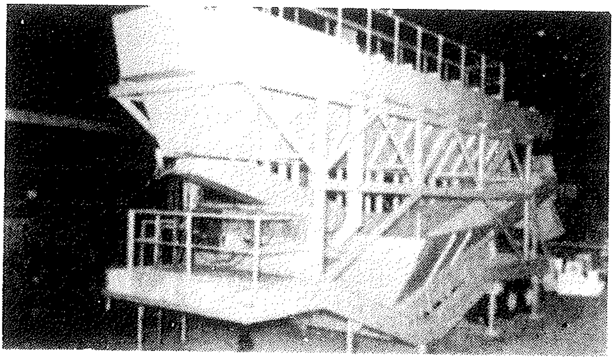
McLanahan Coarse Material Screw Washers are equipped with the same bearing choices as the line of Fine Material Screw Washers. Please refer to page 15-19 for a description of McLanahan submerged bearings.

PORTABLE SAND PLANTS

The Portable Plants are designed for frequent and rapid plant movement, when set-up time and expense must be kept to a minimum. The Semi-Portable Plants are intended for low-head applications where relocation is less frequent and complete portability is not required; yet, where relative ease of movement is necessary.

PORTABLE

These are trailer-mounted units which include a Sand Classifying Tank with triple collector flume and a double Fine-Material Screw Washer. Each Tank is nestled inside the Screw Washer to minimize the overall height to permit over-the-road transportation. The flume is built into the Screw Washer and forms a divider between the two Screws. This permits the operator to produce two different specification products with the tank; or can be adjusted to produce the same product in each Screw. When producing a mason sand with one-half the Screw Washer, the speed is reduced to one-half standard for proper dewatering of this finer material.



SEMI-PORTABLE

Design is available in either low profile or standard height modular units. The Tank is equipped with structural steel legs to facilitate mounting on foundations. The Screw Washer, which sits directly on the foundation, is attached to the Tank by means of bolts.

With the low profile design the Tank is nestled inside the Screw Washer which is normally of Double Screw design. The collecting flume forms a divider between

SEMI-PORTABLE
(continued)

the two sections of the Screw, permitting the operator to make either one or two specification products as desired. To transport the plant, foundations are prepared at the new location, then the Tank is lifted off and placed on a lowboy. The Screw is then lifted onto a second unit and transported to the new site where it is reinstalled first. All wiring is directed to a central control panel with plug-in circuits. This is normally transported with the tank section.

LOG WASHERS

In 1894 McLanahan Corporation produced and patented the first single and double Log Washers with steel paddle shafts. It is obvious that McLanahan Corporation offers the industry's broadest Log Washer experience.

As a brief note of explanation, the name "Log Washer" is a misnomer having confused people for many years by insinuating that the machine is designed for washing logs. Actually the unit derived the name "Log Washer" because the original machine incorporated wooden logs as paddle shafts, thus the name "Log Washer."

Log Washers are used in a variety of applications; however, in the aggregate industry they are known best for their ability to remove tough, plastic soluble clays from natural and crushed gravel, crushed stone and ore feeds. It is recommended that the -1/4" fraction be screened out ahead of the Log Washer since the finer materials will tend to cushion the washing action. This -1/4" fraction should only be fed to the Log Washer when severe washing of fines is required. When these fines are included in a Log Washer feed it may be necessary to capture the overflow water of the Log Washer in order to save the -1/4" solids fraction for further processing.

In operation, a Log Washer sits at a slope which can be varied between 0 and 14 degrees, depending upon the severity of washing required. As the percentage of deleterious material increases, the slope must be elevated which increases the retention time. However, the capacity capability decreases as the slope of the machine increases.

LOG WASHER SIZING AND SELECTION

McLanahanCorporationmanufacturestwo series of Log Washers. The Mudmaster Log Washer series is available in 36" and 38" diameter paddle swings. The 36" Mudmaster Log Washers are made in lengths of 25' and 30'. The 38" model is furnished in 25', 30', and 35' lengths.

The Super Mudmaster Log Washer has a available in 30' and 35' lengths.

The length of Log Washer affects the retention time of the material being washed. The longer the washer box the higher the retention time will be. When selecting a Log Washer for an application, the amount, type and percentage of deleterious material to be removed from the crushed aggregate or gravel must be considered. As the percentage of deleterious clays and silts increase,

LOG WASHER SIZING AND SELECTION
(continued)

longer length Washers in order to increase the amount of washing time the material experiences. In very severe washing applications, two or more Log Washers may be required in series.

A number of items must be taken into consideration when sizing and selecting Log Washers for an application. In addition to determining the type and percentage of deleterious material contaminating the Log Washer feed as described above, it is also necessary to determine the capacity requirements. Another important factor to take into consideration is the size and shape of material to be washed. A Log Washer handling a crushed and angular material will have a lower capacity than a Log Washer handling a round or natural type river gravel. This difference is evidenced by figure 17 which outlines the capacity limitations and water requirements for the Mudmaster series Log Washers.

Size	CAPACITY* (tph)		WATER REQUIREMENT		
	Round or Natural	Crushed or Angular	Spray Bar	Box & Thimble Brg.	Aqua-Lube Brg.
36"	80-110	60-90	75-150 gpm @75 psig	112 gpm @30 psig	25-150 gpm @30 psig
38"	90-125	75-100	100-200 gpm @75 psig	112 gpm @30 psig	25-150 gpm @30 psig
46"	140-175	110-040	100-200 gpm @75 psig	112 gpm @30 psig	25-150 gpm @30 psig

*Capacity varies with percent of tenacity of clay to be removed.

Figure 17. Capacity Capabilities and Water Requirements for McLanahan Mudmaster and Super Mudmaster Log Washers.

The Super Mudmaster Log Washer is also affected by the shape of aggregate being fed to it as shown by this same capacity chart.

It should also be pointed out that the Mudmaster Log Washers are designed for handling a screened 3" top size (screening being accomplished on square openings). The Super Mudmaster Log Washer series, on the other hand, is capable of handling up to a 5" screened top size (screening being accomplished on square openings).

McLanahan Mudmaster Log Washers do provide flexibility and versatility for varying application circumstances. Our standard Log Washers are equipped with adjustable weirs at the overflow openings. This adjustable weir arrangement will permit a change in the water depth which in turn can affect the quality of the washed product. Increasing and decreasing water rates can also affect the finished product quality and as stated previously, the slope adjustment feature can also be used to adjust product quality.

LOG WASHER SIZING AND SELECTION
(continued)

McLanahan Mudmaster Log Washers are equipped with a spray bar for aggregate washing prior to discharge; however, it is recommended that a rinsing screen be placed following the Log Washer in order to provide a final rinse of the washed aggregates.

LOG WASHER DESIGN

McLanahan Log Washers utilize heat treated high carbon steel paddles which are designed to cut through clay balls and break them into smaller pieces to speed the dissolving process. Our paddle design also permits our Log Washers to operate at a lower cost from a horsepower consumption standpoint.

All McLanahan Log Washers are furnished with Aqua-Lube submerged bearings as standard equipment. Twin-Seal Pak roller bearings are also available as an option.

The Aqua-Lube bearing, which is illustrated in figure 18, is a water lubricated type bearing requiring at least 30 P.S. I. of clean, clear water at gallonage rates as outlined in figure 17. The Twin-Seal Pak roller bearing, on the other hand, is a unique submerged bearing system which incorporates twin grease lubricated seals to keep water and even the smallest sand particles from reaching the bearings and bearing support shaft. (see figure 19)

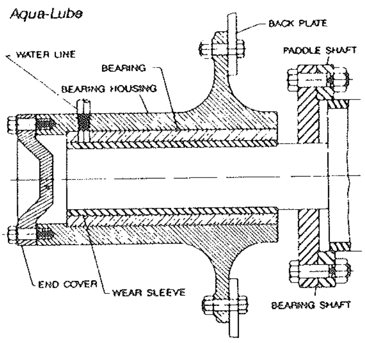


Figure 18. Aqua-Lube Feed End Bearing.

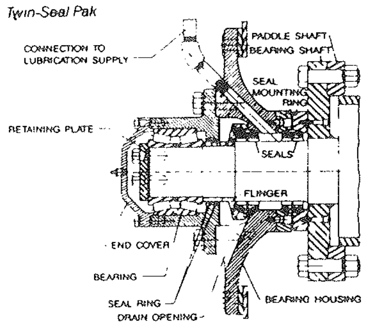


Figure 19. Twin-Seal Pak Roller Bearing at Feed End.

McLANAHAN HEAVY DUTY SCRUBBERS

McLanahan Heavy Duty Scrubbers are designed primarily for the removal of loam, light clays and soft waste materials from aggregate, stone and ore. In operation, material is fed through one end of the Scrubber. The Scrubber is driven at such a speed that the material is retained on lifter shelves until it nearly reaches the top of the cylinder where it cascades and tumbles back on itself, resulting in the breakdown of the softer fractions which are removed by rinsing. This tumbling occurs throughout the Scrubber drum length until it is discharged out the opposite end.

Heavy Duty Scrubbers are not intended to replace Log Washers on applications where tough, plastic clays are contaminating the material to be washed. When tough, plastic clays are fed to a Heavy Duty Scrubber, the tendency is for the clay particles to pelletize through the tumbling action of the Scrubber. While pelletizing, the clay lump becomes larger as it picks up sand and gravel particles in a snowballing effect.

Heavy Duty Scrubbers and Coarse Material Screw Washers are normally used on similar applications; however, a Heavy Duty Scrubber is selected when the top feed size cannot be controlled. Coarse Material Screw Washers have a limit on the top size they can handle; however, Heavy Duty Scrubbers are more flexible and are capable of handling larger size feeds.

SCRUBBER SIZING AND SELECTION

McLanahan Scrubbers effectively handle feed sizes up to nominal 8" to 10" maximum. Capacities are determined based upon the following,

- Percent and type of waste material to be removed
- Screen analysis of the feed material
- Type of feed
- Available water (G.P.M.)

The nominal retention time of the McLanahan Heavy Duty Scrubber is approximately 60 seconds.

In addition to providing dimensional information for McLanahan Heavy Duty Scrubbers, figure 20 provides a capacity chart outlining the capacity in tons per hour, water requirements in gallons per minute, and the recommended motor horsepower. We call attention to the capacity ranges stated. It should be noted that the Scrubber capacities should fall within the stated range for each given size Scrubber.

SCRUBBER SIZING AND SELECTION

(continued)

SIZE	Wt, (lb-Empty)	Capacity (TPH)[1]	Water (GPM)[2]	Motor H.P.[3]
5'-0" Dia. x 10'-0"	23,690	35-70	190-325	50
6'-0" Dia. x 12'-0"	29,000	60-120	325-500	75
7'-0" Dia. x 14'-0"	41,900	90-180	525-800	125
8'-0" Dia. x 14'-0"	47,500	125-250	690-1050	150
10'-0" Dia. x 20'-0"	94,200	250-500	1050-1400	200

1. Capacity based on material weighing 100 lbs/ft3 will vary with retention time required which is a function of percent and type of waste to be removed.

2. Water volume required varies with percent and type of waste.
Will be on high side with use of desander or trommel screen extension

3. NEMA C 1200 RPM

Figure 20. Capacity Capabilities of McLanahan Heavy Duty Rotary Scrubbers

McLanahan Heavy Duty Scrubbers provide considerable flexibility in handling a variety of application requirements.

In more severe scrubbing applications, McLanahan Corporation has found the need to incorporate paddles on the inside of the Scrubber drum. These paddles which can be adjustable will enhance the agitation provided by the Scrubber and therefore produce a cleaner product. Improved washing can also be accomplished by adjusting the water flow rate to the Scrubber. When adjusting the water flow rate to a Scrubber, it is necessary to monitor the effect of the water on the washed product. Too much water may have a tendency to float the aggregate in the Scrubber and therefore diminish the aggressive washing effect which the Scrubber is designed to perform. On the other hand, too little water can also reduce the amount of washing through agitation which the Scrubber is designed to perform.

DESANDER SECTION

The Scrubber can be furnished with a desander section which is designed to remove the sand fraction of your incoming feed if screening is not employed ahead of the Scrubber. If a Screen is in fact employed ahead of the Scrubber then the desander section is not normally required. Figure 21 illustrates the way in which the counterflow of fine material and water is discharged through the desander section.

The desander section consists of a perforated steel plate with large diameter holes. This plate serves as the feed end of the Scrubber. A center opening allows material to enter the unit from the feed chute. Renewable screen cloth with holes of desired size is bolted to the interior of the desander plate. The desander hood collects sand and water, transferring it by flume to other equipment for processing.

DESANDER SECTION
(continued)

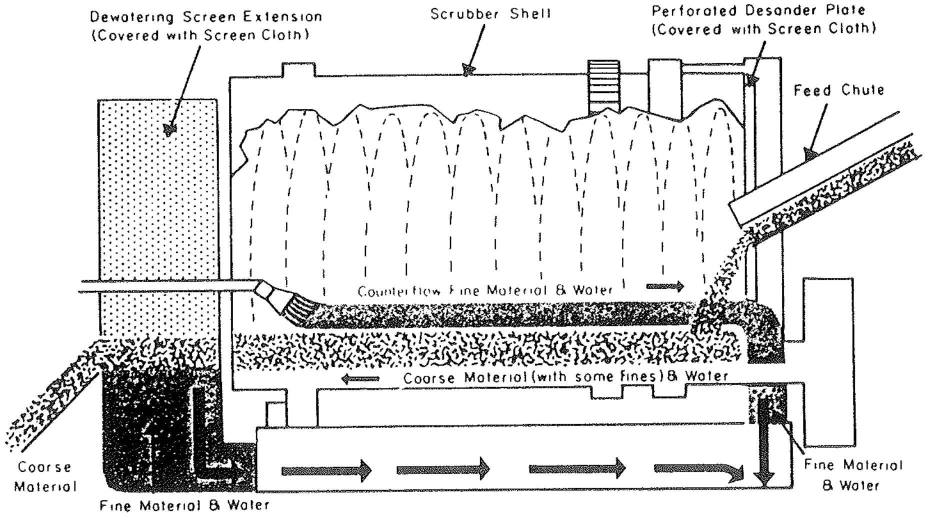


Figure 21. Operating Characteristics of the Desander Section and Dewatering Screen of McLanahan Heavy Duty Rotary Scrubbers.

DEWATERING SCREEN EXTENSION

The Rotary Scrubber can also be equipped with a dewatering screen at the discharge end. This dewatering screen consists of rolled perforated plate bolted in position. The plate normally has large diameter holes and is covered on the inside with renewable screen cloth of desired opening. As the scrubbed product passes over the dewatering screen it is rinsed, causing the fine material to pass through the screen openings and be transferred to other equipment for processing. If a rinsing screen is utilized following the Scrubber the dewatering screen attachment may not be required.

McLANAHAN ROTARY TROMMEL SCREENS

McLanahan Corporation has been manufacturing Rotary Trommel Screens for more than 50 years. Rotary Trommel Screens have seen extensive service in a variety of applications.

Normally the Rotary Trommel Screen is utilized in an application where a light washing is required in addition to the screening function which it performs. The tumbling effect which the Rotary Trommel Screen provides exposes all surfaces of the feed material to rinsing sprays which are located in the center of the Screen.

McLANAHAN ROTARY TROMMEL SCREENS
(continued)

McLanahan Corporation has also manufactured a complete line of combination Scrubber-Screens. The Scrubber-Screen is nothing more than a rotary scrubber section coupled with a single or double trommel screen. Working in combination, the Scrubber-Screen will perform an aggressive scrubbing on the feed material after which it is discharged on to the trommel section for a very efficient rinsing and screening.

As shown on figure 22 there are a number of different sizes of Rotary Trommel Screens and combination Scrubber-Screens available.

Standard Screen Sizes				
Diameter	x	Screen Length	x	No. of Shells
5'		8'		1
5'		10'		1
5'		14'		1
5'		20'		2
6'		19'		1
6'		23'		1
7'		20'		1
7'		25'		1
8'		15'		2
8'		23'		1

Scrubber Screens							
Drum Diam.	x	Drum Length	-	Inner Screen Diam.	x	Screen Length	Overall Length
6'-6"		10'		6'-6"		18'	28'
7'-6"		10'		7'-6"		18'	34'
10'-0"		15'		10'-0"		18'	40'

Available in single and double shell models.

Figure 22. Standard Sizes for McLanahan Rotary Screens and Rotary Scrubber-Screens

ROTARY SCREEN SIZING AND SELECTION

When sizing and selecting Rotary Screens for an application it is necessary to take the following into account,

- Basic capacity requirements
- Percentage of one-half product size in feed
- Percentage of oversize in feed
- Condition or state of material to be screened and/or washed
- Weight factor in terms of pounds per cubic foot
- Inclined factor when Screens are set at a slope
- Effective screen area factor

Due to the number of variables that can be encountered when sizing and selecting Rotary Screens, it is recommended that McLanahan Corporation sales personnel be consulted when sizing and selection of a Rotary Screen is required.

SCRUBBER-SCREENS

For special washing and screening applications, McLanahan Corporation has developed a line of combination Scrubber-Screens. These units combine the scrubbing characteristics of a McLanahan Heavy Duty Scrubber with the screening characteristics of a McLanahan Rotary Trommel Screen all in one unit.

The screen section can be offered as a single or double shell type. The double shell design will allow for the separation and sizing of three different products.

Combination Scrubber-Screens have been most effective when handling hard to wash and screen materials such as oyster shells and phosphate matrix. These units come in a variety of sizes and designs, therefore it is recommended that any potential application be referred to qualified personnel at McLanahan Corporation for sizing and selection of equipment.

Nordberg®

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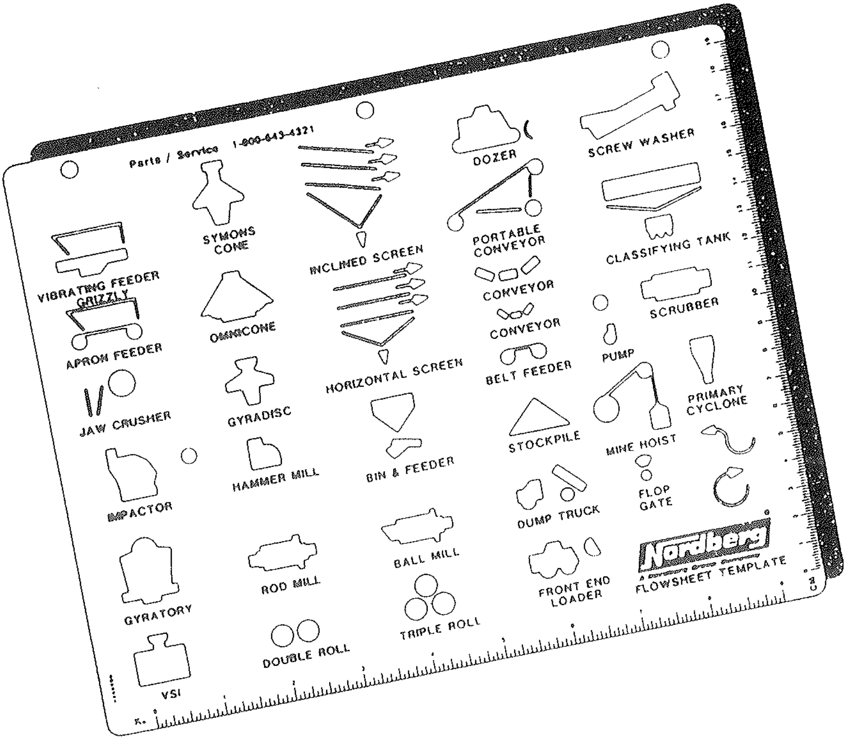
Systems Design Data



CRUSHING AND SCREENING EQUIPMENT SELECTION EXAMPLE

The equipment required and the plant feed analysis will vary greatly depending on whether the raw material is from a gravel deposit or from a quarry. As a guide, an example of a gravel plant flowsheet is shown on FLO-B-628 and a quarried rock flowsheet on FLO-B-629. The detailed procedure of the gravel plant equipment selection is given. The same procedure is used in selecting equipment for the plant crushing blasted quarry rock.

With proper flowsheet design and good maintenance procedures, a plant operating efficiency off approximately 85% is reasonable. For example, a crushing plant designed for 400 TPH will produce approximately (400 TPH) x (.85) x (8 Hr/Day) = 2720 Tons/Day. Good operating efficiency depends on equipment selection, sufficient surge pile and surge bin capacity, practical automation and correct crusher cavity design.

REFERENCE: Drawing FLO-B-628

PRODUCTION REQUIREMENTS	ANALYSIS OF PIT RUN MATERIAL		
Coarse & fine aggregate size as follows:	Size (Inches)	Size (mm)	% Passing
1-1/2" x 3/4" (37mm x 19mm)	15"	381	100
1" x 1/2" (25mm x 12mm)	10"	254	95
3/4" (19mm) x No. 4	3"	76	80
1/2" (12mm) x No. 4	2"	51	74
No. 4 x 0	1"	25	61
	3/4"	19	53
	1/2"	12	40
	3/8"	9	33
	No. 4		20
	No. 10		11

Feeding the plant this material we recommend the following:

a. **Vibrating Grizzly Feeder:** To scalp off the small amount of +4" material as feed to the primary crusher.

Recommendation: Nordberg 45" x 16' vibrating grizzly feeder serves the dual purpose of scalper and feeder. See Section 14.

b. **Primary Crusher:** To crush 15" x 4" material - approximately 115-150 TPH.

Recommendation: Nordberg C100B (30" x 40") heavy-duty jaw crusher. Size determined from Section 3.

c. **Plant Feed Control:** A material source to provide constant feed for continuous plant operation.

CRUSHING AND SCREENING EQUIPMENT SELECTION EXAMPLE
(continued)

Recommendation: Stockpile of grizzly undersize and jaw crusher product. Tonnage of material drawn from stock pile may vary as pit run analysis changes.

d. **Sizing Screen No. 1:** This screen accepts material from stock pile and extracts the +3/4" fraction for feed to the secondary crusher. Screen No. 1 also separates 3/4" x No. 4 and No. 4 finished products.

Recommendation: 6' x 16' - 3 deck Nordberg screen. Size of Screen No. 1 arrived at by using Nordberg screen capacity charts. Analysis of feed to screen can be estimated using above pit run analysis with analysis of jaw crusher discharge.

e. **Material Flow Control:** To divert 1-1/2" x 3/4" material to secondary crusher or to finished product.

Recommendation: Flop Gate.

f. **Secondary Crusher:** To crush 4" x 3/4" fraction.

Recommendation: 4-1/4' Symons standard cone crusher with I" C.S.S. To determine size of crusher refer to Symons cone section 6. Select medium liner per TD4-102 from crusher cavity tables. NOTE: Omnicone or HP Series cone crusher could also be used.

g. **Sizing Screen No. 2:** To separate discharge from both the secondary and tertiary crushers. Is in closed circuit with tertiary crusher.

Recommendation: 6' x 16' 3 deck Nordberg screen. Procedure of determining size to follow.

h. **Material Flow Control:** To divert I" x 1/2" material to tertiary crusher or to finished product.

Recommendation: Flop Gate.

i. **Tertiary Crusher:** To crush +1/2" material from screen No. 2

Recommendation: 4-1/4' Short Head cone crusher with 1/2" C.S.S. NOTE: Omnicone or HP Series cone crusher could also be used. Procedure of determining size described below. Select fine liner per TD4-091 from crusher cavity tables.

Applying these tonnages to the Nordberg screen capacity chart we find a 6' x 16' 3 deck screen is required.

Applying these tonnages to the Nordberg screen capacity chart we find a 6' x 16' 3 deck screen is required.

j. **Material flow Control:** To divert 3/4 x No. 4 material to finished product or to Gyradisc crusher.

Recommendation: Flop Gate.

k. **Material Source for Gyradisc Crusher:** Separate section of plant. Will be operated when increased sand production is required. Gyradisc crusher must operate under full choke load.

Recommendation: Surge Bin.

l. **Feed Control for Gyradisc Crusher:** Optimum performance of Gyradisc crusher is dependent on steady controlled feed rate.

Recommendation: Mechanical Feeder.

CRUSHING AND SCREENING EQUIPMENT SELECTION EXAMPLE
(continued)

m. **Fine Reduction Crusher:** To product- No. 4 sand.

Recommendation: Nordberg 48" Gyradisc crusher. Refer to Nordberg Gyradisc crusher section 10 for capacity figures.

n. **Sand Screen:** To close the circuit with Gyradisc crusher and separate the - No. 4 x No. 8 and - No. 8 sands.

Material Size	From 4-1/4' Std.	From 4-1/4' S.H.	Composite as Feed to Screen No. 2
+ 1"	80 TPH		80 TPH
-1" + 1/2"	76 TPH	55 TPH	131 TPH
- 1/2" + No. 4	44 TPH	63 TPH	107 TPH
- No. 4		42 TPH	42 TPH
TOTAL	200 TPH	160 TPH	360 TPH

In determining the size of screen No. 2 and the Tertiary crusher we consider a combination of factors. To size the Tertiary crusher determine the amount of +1/2" material in the 200 TPH discharge from the 4-1/4' Standard cone crusher. Nordberg crusher Data Sheet (see section 6) shows this to be 78 percent or 156 TPH. In addition there is +1/2" material in the 4-1/4' Short Head cone crusher discharge. According to the chart in section 6 it amounts to 55 TPH. Between the two crushers the total +1/2" material is 211 TPH. The flop gate diverts a portion of the -1" x 1/2" fraction to finished product and controls feed within the capacity of a 4-1/4' Short Head crusher in closed circuit at a 1/2" C.S.S.

To determine size of screen No. 2 combine analyses material discharged from both the 4-1/4' Standard and 4-1/4' Short Head crushers. Use Nordberg crusher in section 6. Figures are as follows:

Recommendation: 6' x 16' 2 deck Nordberg screen. To calculate sand screen size take tonnage and analysis figures of Nordberg Gyradisc crusher. See section 10 and apply them to Nordberg screen capacity chart.

o. **Material Flow Control:** To return portion of - No. 4 x No. 8 sand to feed bin of Nordberg Gyradisc crusher.

Recommendation: Flop Gate.

p. **Fine Sand Control:** Most specification sand limits amount of material minus 100 and 200 mesh.

Recommendation: Sand Screw Classifier.

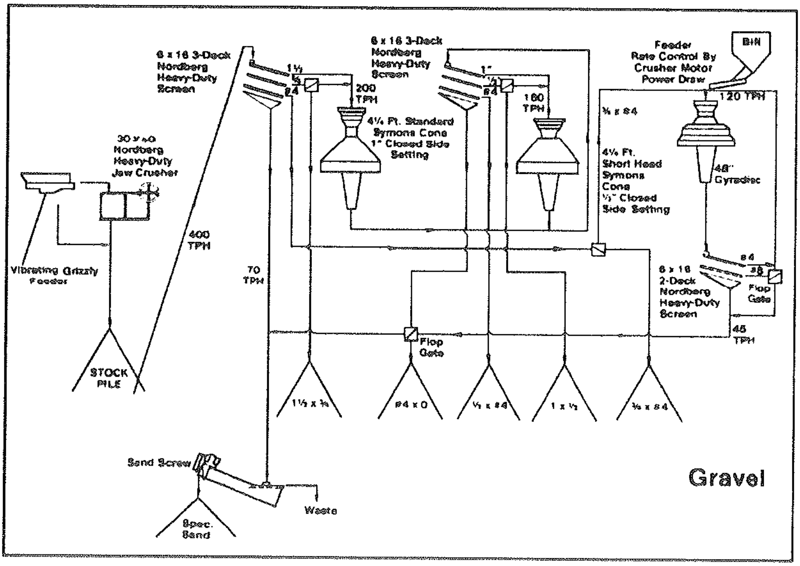
q. **Material Flow Control:** Some sand usable as No. 4 x 0 is stockpiled. If pit run does not provide sufficient - No. 4 material to produce required tonnage of spec. sand, provision is there to divert No. 4 x 0 sand to sand screw.

Recommendation: Flop gate located in - No. 4 product collection circuit of Screen No. 2.

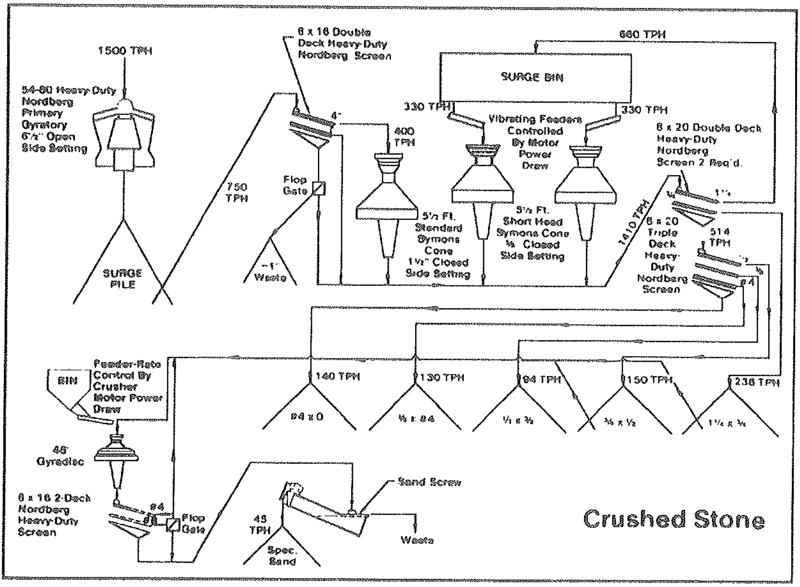
Conveyor requirements are dependent on physical layout of plant.

COARSE AND FINE AGGREGATE PRODUCTION

FLO-B-628



FLO-B-629



CRUSHER APPLICATION

Crushing can be defined as a mechanical operation where pressure is applied to rock in a manner that produces a mechanical failure, and a subsequent size reduction of material is brought about. There are essentially four methods of size reduction used in all commercial crushers; compression, impact, attrition, and shear. The last two, although important factors in crushing action, are generally found in combination with compression and impact. Selecting the right machine for the job will be the difference between good crusher performance with low maintenance and unsatisfactory crusher performance with high maintenance costs.

Some jobs have limiting factors which will dictate the type of crusher to be used; whether it will be compression type or an impact type crusher.

Some factors involved for proper crusher selection are: 1. Type of rock; 2. Capacity required; 3. Product specifications; 4. Power considerations; 5. Initial costs.

Granites, siliceous gravel, and other such abrasive rocks, including some limestones, are generally better handled by the compression type rather than the impact type machine. Even with the advances in new wear resisting alloys for use in impact crushers, these machines are still not recommended for the above mentioned rock.

In hard rock crushing where the major final product sizes are minus 1/2" to minus 3/4" a three stage crushing plant is usually considered. When finer sizes are required, a four stage plant is recommended (with the advanced technology employed in Nordberg's HP Series of crushers, it is possible to use a two stage system to produce these finer sizes). The following table shows the crusher types used together with the ranges of application.

CRUSHING STAGE	CRUSHER NAME AND TYPE	FEED SIZE RANGE	PRODUCT SIZE RANGE
Primary	Nordberg primary gyratory crusher (for plant capacity over 600 TPH)	Up to 60"	6" - 12"
	Nordberg jaw crusher (for plant capacities up to 1300 TPH)	Up to 50"	4" - 12"
	Nordberg horizontal shaft impact crushers (for plant capacities up to 1400 TPH on non-abrasive rock)	Up to 42"	2" - 15"
Secondary	Standard cone crusher	6" - 18"	1-1/4" - 5"
	Horizontal shaft impact crusher	6" - 18"	2" - 8"
Tertiary	Short Head cone crusher	3/4" - 6"	3/16" - 1"
	Horizontal shaft impact crusher	1" - 6"	3/16" - 1"
	Vertical shaft impact crusher	1/2" - 3"	3/16" - 1"
Quaternary (Fourth Stage)	Nordberg Gyradisc crusher	1/4" - 2"	No. 20 - 3/8"
	Nordberg HP cone crusher	1/4" - 1-1/2"	No. 10 - 3/8"
	Vertical shaft impact crusher	1/4" - 1-1/2"	3/16" - 1/2"

CRUSHER APPLICATION
(continued)

The term "Primary Crusher" implies that there is more than one stage of crushing involved in the operation. It could properly be indicated as a crusher handling quarry or pit run material. As this crusher can well be the largest and most expensive piece of equipment in the plant, the most careful study should be made as to its selection.

The capacity of the Primary Crusher should be chosen to exceed the average capacity of the plant, since in most quarries the only surge capacity between the quarry and the primary crusher consists of rock being loaded in crushers and cars. Operating delays will result in subsequent delays at the primary crusher. If the plant is to maintain its rated tonnage, it will have to work at better than average capacity when it starts up again. The reserve capacity could range between 25 to 50%.

Product specifications are important. If a cubical particle is required, an impact crusher may be recommended over the compression type crusher, if the material is compatible to being reduced by the impact type crusher.

If a minimum of fines is important, the jaw crusher, gyratory, or cone type might be chosen over the impact type machines. The desirability of fines would recommend the hammer mill, the Gyradisc or even Nordberg's new HP Series of crusher.

There are always exceptions to the generalized rules. The seemingly infinite considerations of rock characteristics, feed size, product required, tonnage requirements, local conditions, initial and operating costs, and in each case the conditions will have to be weighed differently where a choice of crushers is to be made. The generalized rules would be used only as a preliminary guide. The final decision would have to be arrived at by thoroughly testing the rock.

As shown in the table describing the various crusher types and their ranges of application, the primary crusher may be a jaw crusher in plants designed for approximately 600-1300 TPH. When referring to the capacity table, the discharge setting is considered to be the closed side setting. The product analysis for jaw crushers is shown on the pages is section 3.

When sizing jaw crushers it is considered sound practice to use a crusher setting that is near the center of the range of settings shown in the section 3. For example, operating the crusher at the tighter settings decreases capacity and creates high wear. When operating at the wider settings, a large quantity of slabs could be generated causing delays at transfer points. In addition, the slabs require a large feed opening in the secondary crushing stage causing a loss of efficiency in the crushing cavity.

For plants larger than 600 TPH the primary crusher is likely to be a gyratory. The terminology for describing a gyratory is by first showing the feed opening at the top of the crusher followed by the mantle diameter at the discharge. For example, a 42-70 Nordberg primary gyratory crusher has a 42" feed opening and a 70" mantle diameter. The description of a gyratory crusher product and capacity is based on the open side setting rather than the closed side as normally used on the high speed jaw and Symons, Omnicone and HP cone crushers. The reason for this is that the primary gyratory operates at a much slower speed and consequently the topsize of the rock is influenced by the open side setting particularly during periods when the crusher is not choke fed. Generally, the topsize of the primary gyratory will have a slab size with approximately a 1:2:3 ratio. The "1"

CRUSHER APPLICATION
(continued)

being the open side setting. For example, a primary gyratory crusher operating at 6" open side setting may develop slab sizes measuring 6" x 12" x 18". These dimensions become important when selecting the cavity for the secondary crusher. When sizing primary gyratory crushers, it is considered sound practice to use a crusher setting that is near the center of the range of settings shown in section 2 for the same reasons outlined in the jaw crusher discussion.

Generally, primary gyratory crushers produce a more cubical product in comparison to a jaw crusher. The additional advantages are:

1. Permit use of smaller discharge settings.
2. Capacities are considerably higher, particularly in the range of finer settings.
3. Wear is more evenly distributed in the lower part of the crushing chamber.
4. Ratio of reduction is higher, averaging 8 to 1.

To accurately apply a primary gyratory crusher, it is essential to obtain rock samples for test work. The results of this test work will aid in the horsepower recommendation, eccentric throw, and recommended open side setting.

PRODUCTION OF MANUFACTURED SAND

Manufactured sand is a construction material produced by crushing or grinding, screening, and classifying rock or gravel to meet specifications set forth by the ASTM, Federal and State Highway Departments, and the U.S. Army Corp of Engineers.

The demand for economical and efficient sand producing machinery has grown as natural sand deposits diminish. Prior to the development of the Gyradisc Crusher, manufactured sand was produced by rod mills, impact crushers, and roll crushers. The rod mill is capable of producing fines, but the power and metal cost and the tendency to produce an excess of extreme fines are the principle factors that contribute to the relatively high final cost of rod mill sand. Impact crushers develop high wear rates when crushing abrasive materials and also normally create an excess of extreme fines. Most specifications permit only 2 to 10 percent passing a No.100 sieve, any excess produced in this range must be removed. Roll Crushers, on the other hand, have difficulty in producing a sufficient quantity of fines in the 30, 50 and 100 sieve sizes. Roll shell wear contributes to size control problems and develops high circulating loads.

Experience has shown that material which is excessively wet, sticky or muddy is generally unsuitable for producing manufactured sand in the Gyradisc Crusher. There is no exact moisture content at which the Crusher will become ineffective. An examination of the potential feed by a Nordberg representative will confirm the suitability of the material.

Moisture problems can usually be overcome through the use of dewatering screens before the crusher.

Most materials that qualify as sound construction aggregate can be used as raw material for the sand circuit.

For a successful sand producing circuit, the flow sheet should appear as shown in Figure 1.

PRODUCTION OF MANUFACTURED SAND
(continued)

In a typical sand producing circuit, new feed prescreened on a No. 4 opening enters a surge bin of sufficient capacity to sustain continuous full load operation. The size of the surge bin is related to the efficiency or continuity of the new feed rate entering the sand circuit. Normally, however, the bin sizes should be at least 20 TPH live storage for the 36" Gyradisc Crusher and 40 TPH for the 48", 66" and 84" sizes.

CUMULATIVE PERCENT PASSING

Sieve Size	Test run of minus No. 4 from Gyradisc Crusher circuit	Correction by returning portion of bottom deck oversize (no. 10) to Gyradisc Crusher	Final sand after fines removal	Percent (retained) for fineness modules calculation	ASTM C-33 Specification Sand
3/8" (9mm)	100	100	100		100
No. 4	100	100	100		95-100
No. 8	75	92	91	9	80-100
No. 16	53	64	60	40	50-85
No. 30	35	41	34	66	25-60
No. 50	23	27	19	81	10-30
No. 100	14	17	8	92	2-10

FINENESS MODULES $2.88 = \frac{288}{100}$ 2.3 - 3.1

Note the method of returning the circulating load to the Gyradisc Crusher. Bypassing the surge bin eliminates size segregation in the bin and increases the effective surge capacity. Feed should be prepared before it enters the Gyradisc Crusher surge bin.

A feeder or variable speed conveyor belt takes new feed from the surge bin and delivers it to the crusher. To minimize the reaction time between the control point (feeder) and the Gyradisc Crusher, it is recommended that the crusher be located as close to the bin and feeder as practical. This circuit arrangement is well suited for automation or efficient manual control.

The crushed product should be screened on a double deck dry screen like the Nordberg Inclined Two-Bearing Screen. The exact sizes of the screen openings will vary and are dependent on the crushing characteristics of the material and the final specification. Usually, a cloth having a No. 4 opening is used on the top deck and a No. 8, 10 or 12 is used on the bottom deck.

PRODUCTION OF MANUFACTURED SAND
(continued)

TYPICAL FLOW SHEET

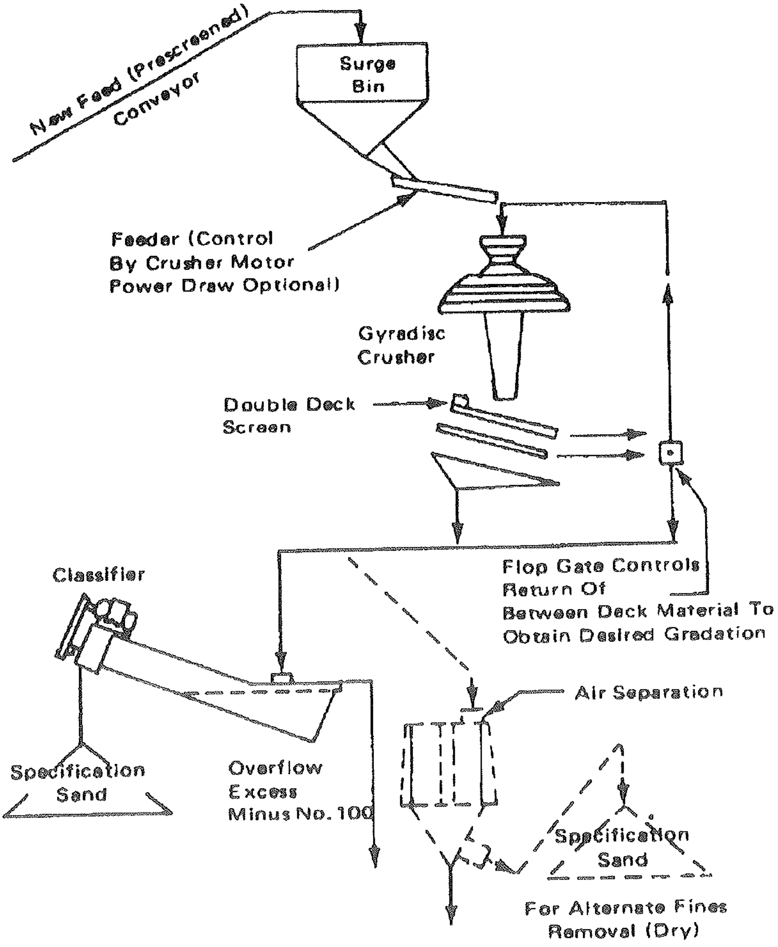


FIGURE 1

PRODUCTION OF MANUFACTURED SAND
(continued)

Figure 2 shows the results of a test conducted, with the Gyradisc Crusher circuit in balance, comparing minus No. 4 screen undersize with ASTM C-33 Specification Sand.

A deficiency in the percentage passing the No. 8 size and an excess in the percentage passing No. 100 resulted during the test. To increase the amount passing the No. 8 size, half of the bottom deck (No. 10) oversize was diverted back to the Gyradisc Crusher by using a flop gate shown in figure 1. The flop gate was adjusted to increase the percentage of between deck material returned as circulating load to the Gyradisc Crusher.

Removal of the excess fines (No. 100) was accomplished through the use of a hydraulic classifier. An air separator can be employed when the disposal of tailing is difficult, when water is unavailable, or where a market exists for excess fines in the form of mineral filler.

An alternate to the sand circuit described above would involve producing a screen undersize consisting entirely of a minus No. 6 or No. 8 Gyradisc Crusher product. This arrangement, however, does not have the built-in flexibility available in the specification sand circuit shown in figure 1.

Operating Cost

Gyradisc Crusher operating-cost-per-tonof sand includes liners, maintenance and power draw. The liner cost is related to the abrasive characteristics of the material being crushed and the surface moisture. Average liner costs are between \$.04 and \$.08 per ton of sand. Proper maintenance, excluding liners, will result in costs not exceeding \$.02 per ton. Power consumption will be in the area of 3 kwh per ton of sand.

The following charts show typical sand circuit gradations for limestone, gravel, and granite.

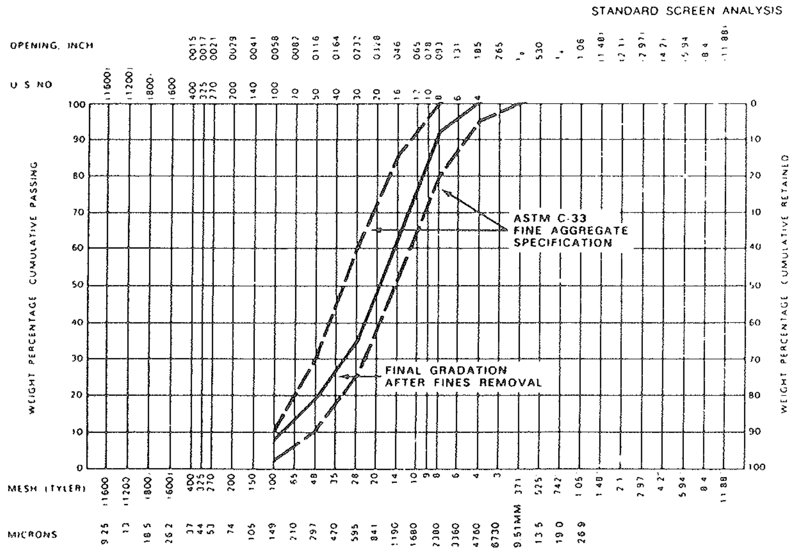


FIGURE 2

END LOADER CAPACITY CHARTS

2 YARD BUCKET

'Haul Distance	Average Speed - MPH								
	2 MPH	3 MPH	3.5 MPH	4 MPH	5 MPH	6 MPH	7 MPH	8 MPH	10 MPH
25′	260	310	325						
50′	180	225	245	260	290				
100′	110	148	165	180	205	228	245	260	
150′	80	110	124	135	160	178	196	212	240
200′	62	88	100	110	130	148	165	178	205
250′		73	84	92	110	126	140	155	178
300′			70	80	96	110	124	135	160
400′					75	88	100	110	130
500′						73	84	92	110

4 YARD BUCKET

'Haul Distance	Average Speed - MPH								
	2 MPH	3 MPH	3.5 MPH	4 MPH	5 MPH	6 MPH	7 MPH	8 MPH	10 MPH
25′	520	620	650						
50′	360	450	490	520	580				
100′	220	290	330	360	410	456	490	520	
150′	160	220	248	270	320	356	392	424	480
200′	124	176	200	220	260	296	330	356	410
250′		146	168	184	220	252	280	310	356
300′		124	140	160	192	220	240	270	320
400′			110	126	150	176	200	220	260
500′					126	146	168	184	220

6 YARD BUCKET

'Haul Distance	Average Speed - MPH								
	2 MPH	3 MPH	3.5 MPH	4 MPH	5 MPH	6 MPH	7 MPH	8 MPH	10 MPH
50′	540	675							
100′	330	444	495	540	615				
150′	240	330	372	405	480	634	588		
200′	186	264	300	330	390	444	495		
250′		219	252	276	330	375	420	465	534
300′		186	210	240	288	330	372	405	480
400′			165	189	225	264	300	330	390
500′					189	219	252	276	330

'One-Way Distance

Above tables based on struck bucket, material weighing 100 lbs./ft.^{3} and 20 seconds allowed for loading, dumping and maneuvering.

END LOADER CAPACITY CHARTS
(continued)

8 YARD BUCKET

*Haul Distance	Average Speed - MPH								
	2 MPH	3 MPH	3.5 MPH	4 MPH	5 MPH	6 MPH	7 MPH	8 MPH	10 MPH
50′	720								
100′	440	592							
150′	320	440	498	540					
200′	248	352	400	440	520	592			
250′		292	336	368	440	504	560		
300′		248	280	320	384	440	496	540	
400′			220	252	300	352	400	440	520
500′					252	292	336	368	440

10 YARD BUCKET

*Haul Distance	Average Speed - MPH								
	2 MPH	3 MPH	3.5 MPH	4 MPH	5 MPH	6 MPH	7 MPH	8 MPH	10 MPH
150′	400	550	620	675					
200′	310	440	500	550	650	740			
250′		365	420	460	550	630	700	775	
300′		310	350	400	480	550	620	675	800
400′			275	315	375	440	500	550	650
500′					315	365	420	460	550

1.8 METER BUCKET

*Haul Distance	Average Speed - MPH								
	3.2KMS	4.8KMS	5.6KMS	6.4KMS	8KMS	9.6KMS	11.2KMS	12.8KMS	16KMS
7.6M	236	281	295						
15.2M	163	204	222	236	263				
30.4M	100	134	150	163	186	207	222	236	
45.6M	73	100	112	122	145	161	178	192	218
60.8M	56	80	91	100	118	134	150	161	186
76.0M		66	76	83	100	114	127	141	161
91.2M			63	73	87	100	112	122	145
121.6M					68	80	91	100	118
152.0M						66	76	83	100

*One-Way Distance

Above tables based on struck bucket, material weighing 100 lbs./ft.^{3} and 20 seconds allowed for loading, dumping and maneuvering.

END LOADER CAPACITY CHARTS
(continued)

3.6 METER BUCKET

'Haul Distance	Average Speed - MPH								
	3.2KMS	4.8KMS	5.6KMS	6.4KMS	8KMS	9.6KMS	11.2KMS	12.8KMS	16KMS
7.6M	476	562	590						
15.2M	327	408	444	472	526				
30.4M	200	263	299	327	372	414	444	472	
45.6M	145	200	225	245	290	323	356	385	435
60.8M	112	160	181	200	236	268	299	323	372
76.0M		132	152	167	200	229	254	281	323
91.2M		112	127	145	174	200	218	245	290
121.6M			100	114	136	160	181	200	236
152.0M					114	132	152	167	200

5.4 METER BUCKET

'Haul Distance	Average Speed - MPH								
	3.2KMS	4.8KMS	5.6KMS	6.4KMS	8KMS	9.6KMS	11.2KMS	12.8KMS	16KMS
15.2M	490	612							
30.4M	299	403	449	490	558				
45.6M	218	299	337	367	435	484	533		
60.8M	169	239	272	299	354	403	449		
76.0M		199	229	250	299	340	381	422	484
91.2M		169	210	218	261	299	337	367	435
121.6M			165	171	204	239	272	299	354
152.0M					171	199	229	250	299

7.3 METER BUCKET

'Haul Distance	Average Speed - MPH								
	3.2KMS	4.8KMS	5.6KMS	6.4KMS	8KMS	9.6KMS	11.2KMS	12.8KMS	16KMS
15.2M	653								
30.4M	399	537							
45.6M	290	399	452	490					
60.8M	225	319	363	399	472	537			
76.0M		265	305	334	399	457	508		
91.2M		225	254	290	348	399	450	490	
121.6M			200	229	272	319	363	399	472
152.0M					229	265	305	334	399

'One-Way Distance

Above tables based on struck bucket, material weighing 100 lbs./ft.^{3} and 20 seconds allowed for loading, dumping and maneuvering.

END LOADER CAPACITY CHARTS
(continued)

10 METER BUCKET

*Haul Distance	Average Speed - MPH								
	3.2KMS	4.8KMS	5.6KMS	6.4KMS	8KMS	9.6KMS	11.2KMS	12.8KMS	16KMS
45.6M	363	499	562	612					
60.8M	281	399	454	499	590	671			
76.0M		331	381	417	499	571	635	703	
91.2M		281	317	363	435	499	562	612	726
121.6M			249	286	340	399	454	499	590
152.0M					286	331	381	417	499

*One-Way Distance

Above tables based on struck bucket, material weighing 100 lbs./ft.^{3} and 20 seconds allowed for loading, dumping and maneuvering.

TIRES

LOAD AND INFLATION TABLE

Tire Size	Plys	Max. 5 Miles/Hr.		Max. 20 Miles/Hr.	
		Inflation	Load	Inflation	Load
7:50-20	8	75	5,100	65	3,580
8:25-20	10	85	6,440	75	4,550
9:00-20	12	95	8,140	80	5,630
10:00-20	12	85	8,570	75	6,100
11:00-20	14	95	10,100	85	7,260
12:00-20	16	100	11,850	90	8,510

POWER SHOVELS

SHOVEL SIZES - CAPACITIES

Rated Capacity of Dipper		Max. Stone to Pass Dipper	Swings Per Minute	Capacities Per Hour					
				100%		70%		50%	
Cu. Yd.	Tons			Yd.³	TPH	Yd.³	TPH	Yd.³	TPH
3/4	.675	32" x 35"	2.36	71	96	50	67	35	48
1	.900	33" x 38"	2.23	89	120	62	84	45	60
1-1/4	1.125	33" x 40"	2.15	107	145	75	102	54	73
1-1/2	1.350	30" x 36"	2.10	126	170	88	119	63	85
1-3/4	1.575	33" x 45"	2.00	140	189	98	132	70	95
2	1.800	33" x 45"	1.97	158	213	110	149	79	106
2-1/2	2.250	36" x 48"	1.85	185	250	130	175	93	125
3	2.700	40" x 48"	1.75	210	284	147	198	105	142
3-1/2	3.150	44" x 50"	1.65	231	312	162	218	116	156
4	3.600	48" x 57"	1.57	251	339	176	237	126	170

Rated Capacity of Dipper		Max. Stone to Pass Dipper mm	Swings Per Minute	Capacities Per Hour					
				100%		70%		50%	
Cubic Meter	Metric Tons			M³	Metric TPH	M³	Metric TPH	M³	Metric TPH
0.6	0.6	813 x 889	2.36	54.2	87.1	38.2	61.0	27.0	44.0
0.8	0.8	838 x 965	2.23	68.0	108.8	47.4	76.2	34.4	54.4
1.0	1.0	838 x 1016	2.15	82.0	132.0	57.3	93.0	41.3	66.2
1.1	1.2	762 x 914	2.10	96.3	154.2	67.2	108.0	48.1	77.1
1.3	1.4	838 x 1143	2.00	107.0	171.4	75.0	120.0	53.5	86.2
1.5	1.6	838 x 1143	1.97	121.0	193.2	84.0	135.1	60.4	96.1
1.9	2.0	914 x 1219	1.85	141.3	227.0	99.3	159.0	71.1	113.4
2.3	2.4	1016 x 1219	1.75	160.4	258.0	112.3	180.0	80.2	129.0
2.7	2.9	1118 x 1270	1.65	176.5	283.0	124.0	198.0	88.6	141.5
3.1	3.3	1219 x 1448	1.57	192.0	307.5	134.5	215.0	96.3	154.2

DUMPING ANGLES

Angles at which different type of materials will begin to slide or fall from a tipped body which has as opened end at right angles to the bed of the body. Angle measured from the horizontal.

Asphalt....................................45°

Clay.......................................45°

Coal, hard.................................24°

Coal, soft.................................30°

Coke.......................................23°

Concrete...................................30°

Earth, loose...............................28°

Earth, Compact.............................50°

Gravel.....................................45°

Ore, dry...................................45°

Ore, quarried..............................24°

Sand, dry..................................30°

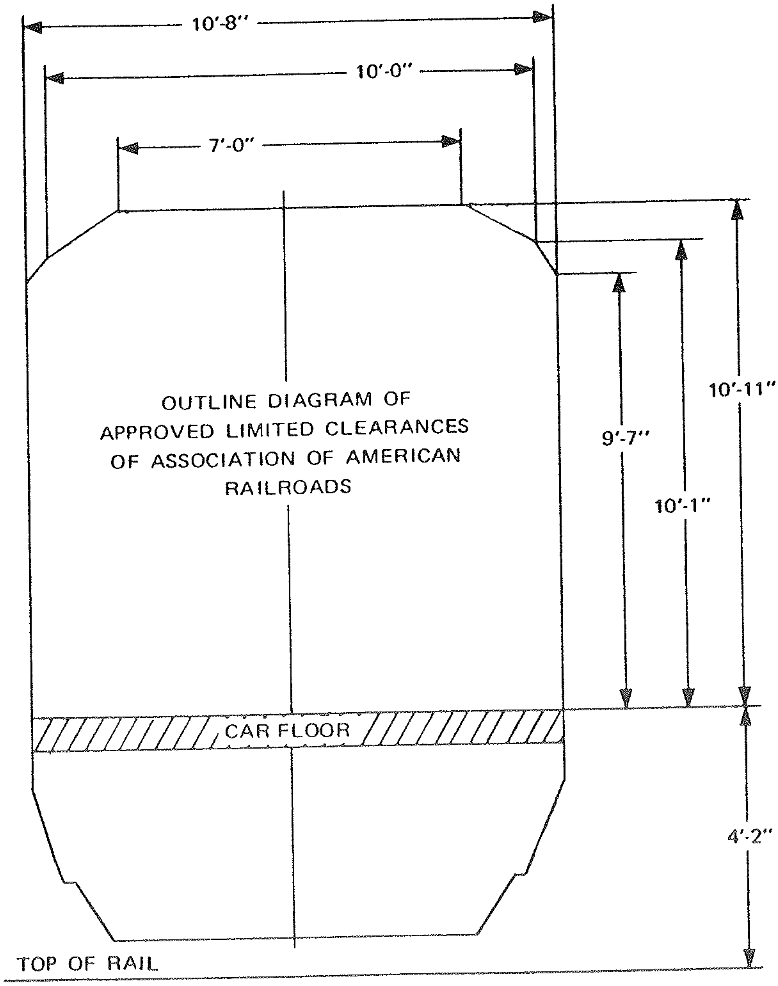
Sand, moist................................23°

Stone......................................30°

Stone, quarried............................28°

Stone, crushed.............................50°

RAILROAD CLEARANCE CHART



NOTE: Diagram Covers Cars of Dimensions Up To:

a) Inside Length Of . . . . 50'-6"

b) Coupled Length Of . . . . 54'-8½"

c) Center To Center Of Truck . . . . 41'-3"

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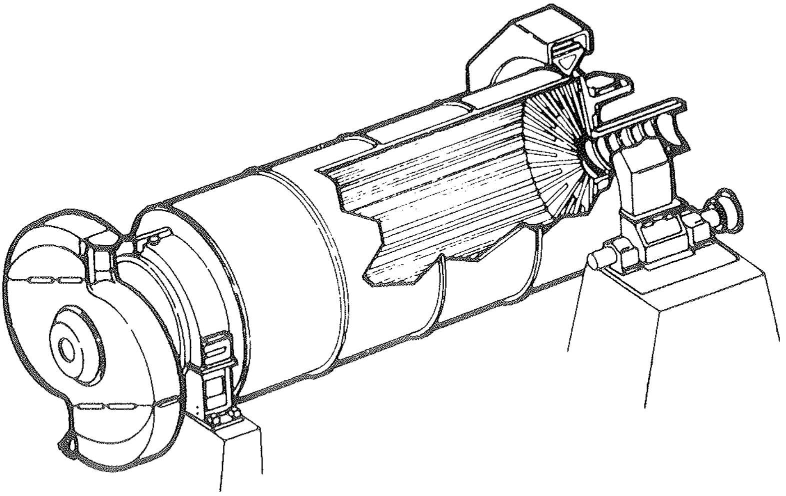
Grinding Mills



GRINDING MILLS

The term "grinding", as used by Nordberg refers to the size reduction of material by tumbling it together with media, in a rotating horizontal cylinder. The media may be steel balls, rods or rock pebbles. Energy is consumed in keeping the mill and media in motion; part of this energy is used to perform the useful work of breaking the material which surrounds the media.

Nordberg Rod, Ball and Pebble Grinding Mills are custom designed and built to meet specified conditions for wet or dry grinding in the manufacture of cement, the fine reduction of metallic and non-metallic minerals and other processes where material must be comminuted to fine sizes.

GRINDING MILL TYPES

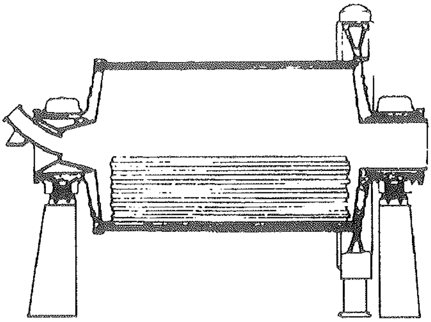
Rod Mills

Rod mills are able to accept feeds up to approximately 2", depending on the hardness of the material. In most cases, an ideal rod mill feed will be minus 3/4" with about 80% passing 1/2". Rod mills are used to produce products with maximum sizes from 4 mesh to as fine as 35 mesh. The rods in a rod mill are in line contact and as a result preferentially grind the largest size particles and produce a product which has a relatively narrow range of size distribution; i.e., very little tramp oversize and very little extreme fines.

Figure 1 shows the various types of rod mill discharge arrangements. Overflow discharge is most common and is used extensively in mining applications. The grinding is done wet and the mill is used to reduce a crushing plant product to a size suitable for ball mill feed.

FIGURE 1

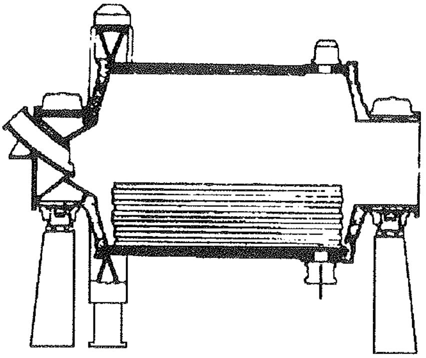
Overflow Discharge



WET GRINDING

Produces ball mill feed.

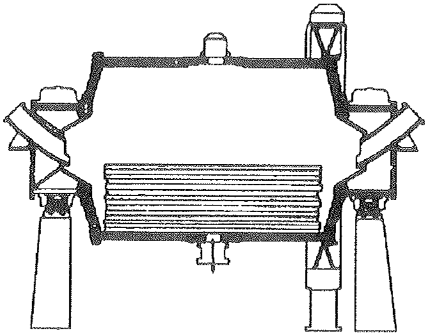
End Peripheral Discharge



WET OR DRY GRINDING

Produces relatively fine product. Also gives a high gradient and good flow rate with dry material.

Center Peripheral Discharge



WET OR DRY GRINDING

Produces rapid discharge and reduced production of extreme fines.

In practice it has been proven that rod mill design is subject to several limitations. The ratio of length to diameter should not be less than 1.2/1. The speed at which the mill is operated should be limited to a maximum of 70% of critical speed and preferably should be in the 60 to 68 percent of critical speed range.

Ball Mills

Ball mills are normally used to produce finely sized products that may range from 35 mesh to 10 microns. As a general rule, hard ores should not be coarser than 80% passing 1/4" and soft ores or cement clinker should not be coarser than 80% passing 1" when fed to a ball mill. Larger feed is undesirable because the large ball diameters that become necessary result in high wear and less efficient grinding.

Figure 2 illustrates the various ball mill discharge arrangements. As with rod mills, the most common discharge arrangement on a ball mill is trunnion overflow. This type of mill operates wet.

Low or intermediate level diaphragm discharge can be applied to either wet or dry grinding. The high gradients that can be obtained with this type of discharge permit rapid flow of dry material, and this helps reduce overgrinding.

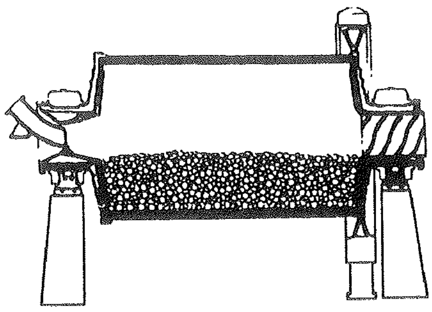
Multiple compartment ball mills are frequently used to produce very high reduction ratios in one unit. The mill is divided into two or more compartments so that the ball charge for each compartment can be sized to achieve the most efficient grinding based on the size of the material entering the compartment.

Ball mills have been successfully run at speeds between 60 and 90 percent of critical speed, but most mills operate at speeds between 65 and 75 percent of critical speed.

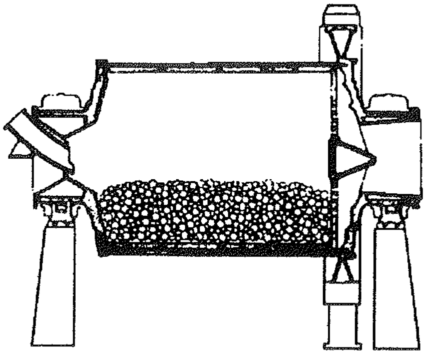
BALL MILLS

FIGURE 2

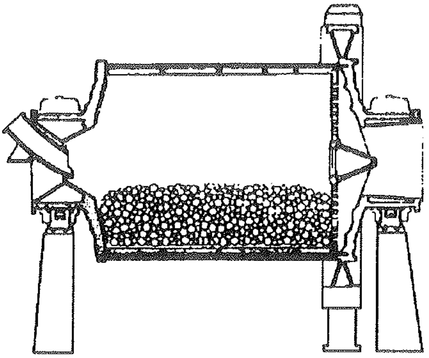
Overflow Discharge



Intermediate Level
Diaphragm Discharge



Low Level
Diaphragm Discharge



Pebble Mills

Pebble mills are used predominantly for secondary grinding in installations where low media costs and liner wear are of prime consideration and the material being ground is capable of forming suitable pebbles. Pebble mills are similar to diaphragm discharge ball mills in nearly all aspects of design. They are usually run at speeds between 75 and 85 percent of critical speed. Pebble mills are considerably larger than ball mills for the same horsepower input. The power drawn by any mill is proportional to the bulk density of the charge, and because pebbles have a lower bulk density than steel balls the volume inside a pebble mill shell must be increased proportionally.

Critical Speed

A grinding mill's critical speed is the lowest rpm which will cause an infinitely small particle on the shell liner to centrifuge. This is expressed by the following equation:

$$CriticalSpeed(rpm) = \frac{76.63}{\sqrt{D}}$$

D = Internal diameter of mill in feet, measured inside shell liners

Example: a mill measuring 11'0' diameter inside of new shell liners operates at 17 3 rpm. Critical speed is

$$C.S. = \frac{76.63}{\sqrt{11}} = 23.1 rpm$$

Mill speed expressed as a percent of critical speed is

$$\frac{17.3}{23.1} = 75\% CriticalSpeed$$

SELECTION OF WET OR DRY GRINDING

Wet grinding is most commonly used in the mining industry because most subsequent processes such as flotation, leaching or magnetic separation are done wet. In areas where water is scarce or where a dry process follows, grinding is done dry. In cement plants, all clinker grinding is done dry because of the nature of the material. but both dry and wet processes are used for grinding of the raw mix. Some considerations are:

1. Wet grinding requires less power per ton of material ground than dry grinding.
2. Wet grinding requires less space than dry grinding if classifiers are required.
3. Wet grinding does not require elaborate dust control equipment.
4. Dry grinding is limited to feed material with a low moisture content. If the moisture content is high, drying is required.
5. Dry grinding uses less media and liner material per ton of material ground than wet grinding.
6. Dry grinding, in open circuit, eliminates the need for filtering and drying of product.

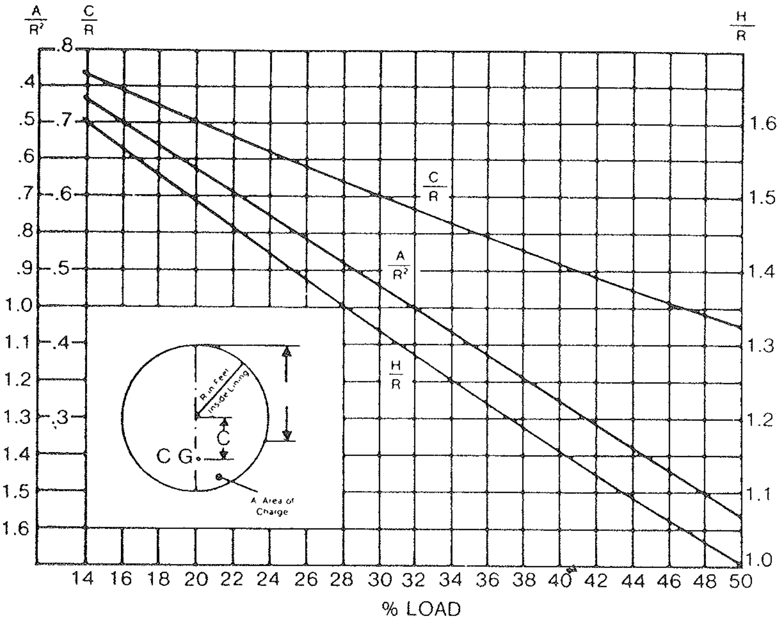
Charge Volume

The charge volume of a ball or rod mill is expressed as the percentage of the volume within the liners filled with balls or rods. When the mill is stationary, the charge volume can be quickly obtained by measuring the diameter inside the liners and the distance from the top of the mill inside the liners to the top of the charge. The percentage loading or charge volume can then be read off the graph in Figure 3 or can be approximated from the following equation:

$$\% \text{ loading} = 113 - 126\frac{D}{H}$$

where H is distance from top of mill inside of lining to top of charge and D is diameter of mill.

FIGURE 3



Center of Gravity:

Read Value on Curve $\frac{C}{R}$, Multiply by R.

Example: Loading 38%, R = 7.5

Curve $\frac{C}{R}$ reads .527 x 7.5 = 3.95 ft = C.

Area of Charge:

Read Value on Curve $\frac{A}{R^2}$, Multiply by R^2

Example: Loading 38%, R = 7.5

Curve $\frac{A}{R^2}$ reads 1.2 x 7.5^2 = 67.4 sq. ft. = A.

Top of Charge to Top of Mill:

Read Value on Curve $\frac{H}{R}$, Multiply by R.

Example: Loading 38%, R = 7.5

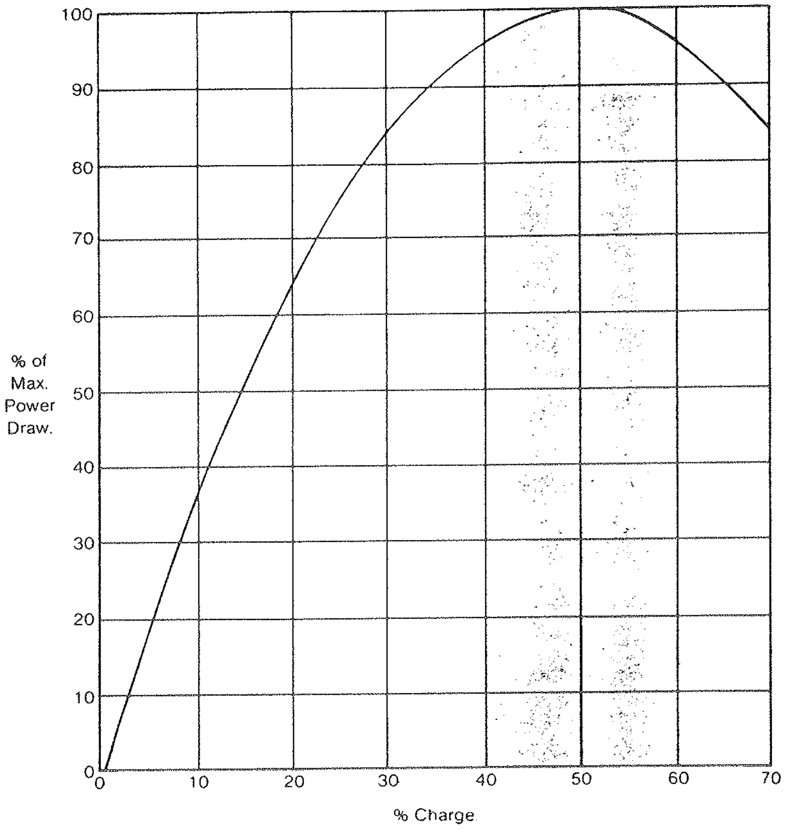
Curve $\frac{H}{R}$ reads 1.19 x 7.5 ft. = 8.9 ft. = H.

Maximum power is drawn by a mill when the charge occupies approximately 50% by volume. However, as seen in Figure 4, the power curve becomes very flat in the range above 45%. As a result, mills are seldom run with charge levels greater than 45%.

In rod mills, the charge is swollen by particles of feed which separate the rods. If the mill is shut down immediately after the feed is shut off, the charge level will be greater than if the mill had been "ground out" prior to shutdown. Because of this, rod mills are normally operated with a 32 to 40 percent charge by volume. In operation, this becomes a 40 to 50 percent charge, with a bulk density considerably lower than that of stacked rods.

Ball mill charges become measurably swollen only when there is a buildup of large unground material in the ball mill or when the density of the pulp in a wet mill is extremely high. Although these conditions are seldom encountered it is recommended that ball mills be ground out prior to shutdown for measurement of the charge level.

FIGURE 4



CALCULATING MOTOR AND MILL SIZE

Determining Horsepower Requirement

The power required to grind a material from a given feed size to a given product size can be estimated by using the following equation:

$$W=\frac{10Wi}{\sqrt{P}}-\frac{10Wi}{\sqrt{F}}$$

where W = power consumption expressed in kwh/short ton (HPhr/short ton = 1.34 kwh/short ton)

Wi = work index, which is a factor relative to the kwh/short ton required to reduce a given material from theoretically infinite size to 80% passing 100 microns

P = size in microns of the screen opening which 80% of the product will pass

F = size in microns of the screen opening which 80% of the feed will pass

When the above equation is used the following points should be borne in mind:

a. The values of P and F must be based on materials having a natural particle size distribution.

b. The power consumption per short ton will only be correct for the specified size reduction when grinding wet in closed circuit. If the method of grinding is changed, power consumption also changes as follows:

1. Wet Grinding, Closed Circuit = W
2. Wet Grinding, Open Circuit, Product Topsize not limited = W
3. Wet Grinding, Open Circuit, Product Topsize limited = W to 1.25W
4. Dry Grinding, Closed Circuit = 1.30W
5. Dry Grinding, Open Circuit, Product Topsize not limited = 1.30W
6. Dry Grinding, Open Circuit, Product Topsize limited = 1.30W to 2W

Open circuit grinding to a given surface area requires no more power than closed circuit grinding to the same surface area provided there is no objection to the natural topsize. If topsize must be limited in open circuit, power requirements rise drastically as allowable topsize is reduced and particle size distribution tends toward the finer sizes.

c. The work index, Wi, should be obtained from test results or plant data, where the feed and product size distributions are as close as possible to those under study.

The work index, Wi will vary considerably for materials that appear to be very similar. The work index will also have a considerable variation across one ore body or deposit.

The most reliable work index values are those obtained from long term operating data. If this is not available, standard grindability tests can be run to provide approximate values.

Rod and ball mill grindability test results should only be applied to their respective methods of grinding.

Nordberg has facilities for performing grindability tests which calculates the work index (Wi) for materials. For more details on the **Grindability Test and the Nordberg Research Facilities** refer to **Chapter 20.**

d. If P is less than 80% passing 70 microns, power consumption will be

$$W\left(\frac{P+10.3}{1.145P}\right)$$

Example 1

A wet grinding ball mill in closed circuit is to be fed 100 TPH of a material with a work index of 15 and a size distribution of 80% passing 1/4 inch (6350 microns). The required product size distribution is to be 80% passing 100 mesh (149 microns). In order to determine the power requirement, the steps are as follows:

1. W =

$$\frac{10Wi}{\sqrt{P}} - \frac{10Wi}{\sqrt{F}} = \frac{150}{\sqrt{149}} - \frac{150}{\sqrt{6350}}$$

= 10.4 Kwh/T

2. HP – HR/T = 10.4 Kwh/T x 1.34 HP – HR/Kwh = 13.9 HP – HR/T

3. HP = 100 T/HR x 13.9 HR – HR/T = 1390 HP or a 1400 HP mill is required.

Matching Mill Size to Horsepower Requirement

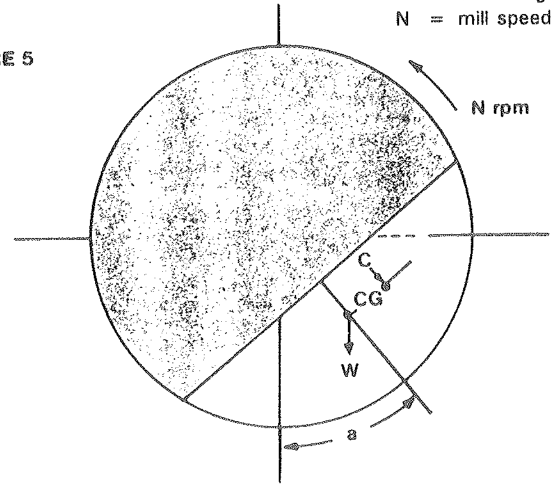
The power requirement calculated at the left is the power that must be applied at the mill drive in order to grind the tonnage of feed from one size distribution to a finer size distribution. The following shows how the size of mill required to draw this power is calculated.

Figure 5 represents a section of a mill in operation. The power input required to maintain this condition is theoretically:

$$hp = \frac{(W)(C)(\text{Sin a})(2\quad)(N)}{33{,}000}$$

where W = weight of charge
C = distance of center of gravity of charge from center of mill in feet
a = dynamic angle of repose of the charge
N = mill speed in rpm

FIGURE 5



The value of the angle a varies with the type of discharge, percent of critical speed, and grinding condition.

In order to use the preceding equation, it is necessary to have considerable data on existing installations. Therefore, this approach has been simplified as follows:

Five basic conditions determine the horsepower drawn by a mill:

1. Diameter 2. Length 3. % Loading
4. Speed 5. Mill type

These conditions have been built into factors which are given in the following tables. The approximate horsepower of a mill can be calculated from the following equation:

HP = A x B x C x L

where A = factor for **diameter inside shell lining**
B = factor which includes effect of % loading and mill type
C = factor for speed of mill
L = length in feet of grinding chamber measured between head liners at shell-to-head junction

Some grinding mill manufacturers specify diameter inside the liners whereas Nordberg mills are specified per inside shell diameter. (Subtract 6" to obtain dia. inside liners.) Likewise, a similar confusion surrounds the length of a mill. Therefore, when comparing the size of a mill between competitive manufacturers, one should be aware that mill manufacturers do not observe a size convention.

FACTORS FOR CALCULATION OF ROD & BALL MILL HORSEPOWER

Diameter					
(mm)	*Dia. Inside Shell Liners (In.)	Factor A	(mm)	*Dia. Inside Shell Liners (In.)	Factor A
2438	8'	32.0	4419	14'-6"	141.5
2590	8'-6"	37.3	4572	15'	154.5
2743	9'	43.1	4724	15'-6"	167.2
2895	9'-6"	49.6	4877	16	181.5
3048	10	56.1	5029	16'-6"	196.0
3200	10'-6"	63.5	5182	17'	211.2
3353	11'	71.1	5334	17'-6"	226.7
3505	11'-6"	79.3	5486	18'	243.6
3658	12'	88.4	5638	18'-6"	260.5
3810	12'-6"	97.5	5791	19'	278.9
3962	13'	108.0	5943	19'-6"	297.8
4114	13'-6"	118.5	6096	20'	317.1
4267	14'	130.0			

*Net Diameter or Diameter Inside Shell Minus 6"

FACTORS FOR CALCULATION OF ROD & BALL MILL HORSEPOWER

(continued)

Mill Type and Loading						
	Factor B					
	Ball Mills			Rod Mills		
% Loading	Dry Diaphragm	Wet Diaphragm	Wet Overflow	Dry Peripheral	Wet Peripheral	Wet Overflow
20	4.30	3.87	3.44	4.73	4.25	3.78
22	4.57	4.12	3.66	5.04	4.54	4.03
24	4.80	4.32	3.84	5.27	4.75	4.22
26	5.07	4.57	4.06	5.58	5.02	4.47
28	5.31	4.77	4.24	5.82	5.24	4.66
30	5.53	4.97	4.42	6.08	5.47	4.86
32	5.71	5.14	4.57	6.28	5.65	5.02
34	5.90	5.32	4.72	6.48	5.83	5.19
36	6.05	5.45	4.84	6.67	6.00	5.33
38	6.16	5.55	4.93	6.78	6.10	5.42
40	6.27	5.65	5.02	6.90	6.21	5.52
42	6.34	5.70	5.08	--	--	--
44	6.41	5.77	5.13	--	--	--
46	6.46	5.82	5.17	--	--	--
48	6.49	5.84	5.19	--	--	--
50	6.50	5.85	5.20	--	--	--

Speed			
% Critical Speed	Factor C	% Critical Speed	Factor C
60	0.1340	74	0.1798
61	.1370	75	.1838
62	.1400	76	.1878
63	.1430	77	.1918
64	.1460	78	.1958
65	.1490	79	.1999
66	.1521	80	.2040
67	.1552	81	.2081
68	.1583	82	.2124
69	.1625	83	.2166
70	.1657	84	.2208
71	.1690	85	.2251
72	.1724	86	.2294
73	.1760	87	.2337

When sizing wet or dry diaphragm ball mills for limestone or cement clinker use B Modified = (0.931)B

Note: Based on steel grinding media. For other types of media and pebble milling, B factor must be adjusted by the ratio of the actual charge density, in lbs. per cubic foot. to 315 or B X charge density 315

Example 2

In Example No. 1 it was determined that a 1400 HP wet grinding ball mill was required to grind 100 TPH of material with a Bond Work Index of 15.0 from 80% passing 1/4 inch to 80% passing 100 mesh in closed circuit.

What is the size of an overflow discharge ball mill for this application?

Step 1: HP = A X B X C X L

Step 2: The effective diameter of a mill is the diameter inside lining; i.e., the net diameter. In this case, the mill under consideration is a new installation so liners will be roughly 3" thick and the net diameter will be 6" less than the diameter inside the shell. Since no diameter has been specified, investigate a range to find the most suitable. From the table the values of A are:

For a net diameter of 10'-6" (3200mm) .... A = 63.5

For a net diameter of 11'-6" (3505mm) .... A = 79.3

For a net diameter of 12'-6" (3810mm) .... A = 97.5

For a net diameter of 13'-6" (4114mm) .... A = 118.5

Step 3: Most overflow discharge mills operate with 35 to 45 percent charge. An average value is 40%. The value of B from the table for a wet overflow mill at 40% is as follows" b = 5.02

Step 4: Speed was not specified, so a range of speeds should be investigated to find the most suitable. From the table the values of C are as follows:

For 68% of critical speed .... C = 0.1583

For 72% of critical speed .... C = 0.1724

For 76% of critical speed .... C = 0.1878

Step 5: Solving for length of the mill with 02'-6" net diameter, 40% charge and 68% of critical speed required to draw 1400 HP:

$$L = \frac{1400}{63.5 \times 5.02 \times 0.1583} = 27.7 \text{ FT.}$$

The length required for each of the above diameters and speeds is tabulated below.

		SPEED		
DIAMETER INSIDE SHELL	NET DIAMETER	68% OCS	72% OCS	76% OCS
11'-0" (3353mm)	10'-6" (3200mm)	27.7' (8409mm)	25.5' (7747mm)	23.4' (7112mm)
12'-0" (3658mm)	11'-6" (3505mm)	22.2' (6757mm)	20.4' (6198mm)	18.7' (5665mm)
13'-0" (3962mm)	12'-6" (3810mm)	18.1' (5511mm)	16.6' (5029mm)	15.2' (4623mm)
14'-0" (4267mm)	13'-6" (4114mm)	14.9' (4496mm)	13.7' (4141mm)	12.5' (3784mm)

Step 6: Choose the particular combination of diameter and length which seems best suited to your application. The following points should be considered in making this selection.

1. Length to diameter ratio - rod mill ratios normally fall between 1.2/1 to 1.6/1; ball mill ratios normally fall between 1/1 to 5/1.
2. Speed selection - the slower the speed, the less wear on media and liners; the faster the speed, the lower the capital cost.
3. The mill sizes obtained from the preceding calculation will be a first approximation only, because just the five major factors that affect horsepower drawn have been considered. Feed size, work index, product size, viscosity, pulp density, ore bulk density, liner design, hydraulic gradient in the mill and quality of media all have an effect on the power drawn and on the efficiency. While the size you select will be accurate enough for preliminary planning, **Nordberg should be consulted before the final size selection is made.**

The following information is required to determine the mill size accurately.

GRINDING MILL INFORMATION SHEET

1. Material To Be Ground
2. Material Characteristics
3. % Moisture In Feed
4. Grinding Index (if known)
5. Density of Feed
   Lbs./Cu. Ft.
6. Specific Gravity
7. Desired Capacity
   (Dry Solids Per Hour)
8. % Solids and/or Pulp Density
9. Feed Size — Maximum Size
   Feed Size - 80% Passing Size
10. Product Size — 80% Passing Size
11. Type of Circuit: Wet Dry Open Closed

Additional Information: (Available Power, Type of Drive Preferred, etc.)

MILL APPLICATION PROGRAM

Nordberg has a mill application computer program for sizing mills when the above data is available. The following is a sample printout.

GRINDING MILL SIZING
BY
"MAP" - MILL APPLICATION PROGRAM - VERSION 1
****

FOR : XYZ MINING INC.
ABC MINE

BALL MILL WITH OVERFLOW DISCHARGE OPERATING IN CLSD CIRCUIT.
WET GRINDING GOLD ORE

INPUT DATA

18.00 FT. COMPARTMENT LENGTH
12.50 FT. DIA INSIDE SHELL LINERS
12.83 MAX DIA INSIDE WORN LINERS
72.0 MILL SPEED - PERCENT OF CRITICAL
(15.61 RPM BASED ON 12.50 FT DIA)
12.00 WORK INDEX
8100. FEED SIZE (80 PERCENT PASSING) - MICRONS
105. PRODUCT SIZE (80 PERCENT PASSING) - MICRONS
40.0 PERCENT BALL CHARGE

MILL SELECTION/PERFORMANCE SUMMARY

A 13.00 FT DIA. BY 18.0 FT LONG MILL SHELL HAS BEEN SELECTED

THE MILL DRAWS 1528. HP WHEN OPERATED WITH 3.0 INCH THICK LINERS

WHEN THE LINER IS WORN DOWN TO 1.0 INCHES,
1663. HP WILL BE DRAWN AT INDICATED RPM AND PERCENT CHARGE

THE POWER/PRODUCTION RATIO IS 13.50 HP/STPH
CORRESPONDINGLY 1528. HP GRINDS 113.2 ST/HR

NOTE

DUE TO THE VARIABILITY OF ROCK WITHIN AN ORE BODY
AND DIFFERENCES IN MILL OPERATING CONDITIONS AND PROCEDURES,
IT IS NOT POSSIBLE TO GUARANTEE THE PREDICTED PERFORMANCE
OF ANY MILL.

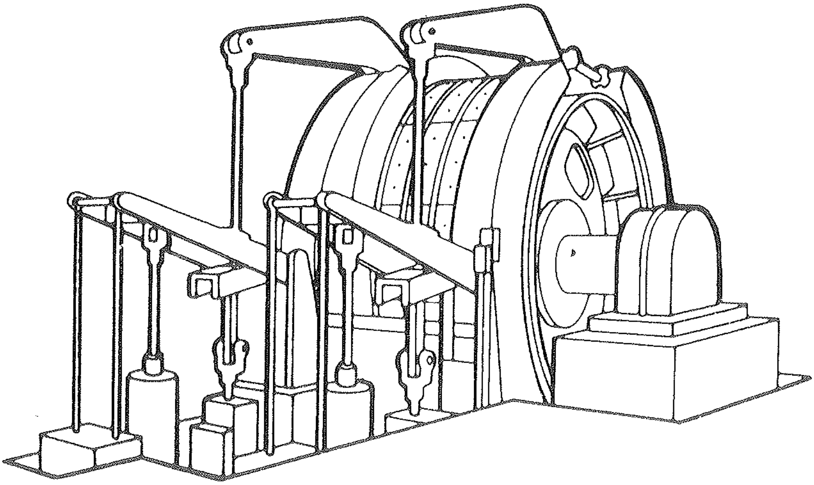
THIS NORDBERG CALCULATION IS BASED ON THE BEST INDUSTRY
STANDARDS WHICH HAVE BEEN CONFIRMED BY MEASUREMENTS
ON OPERATING MILLS.

NORDBERG AMERICAS

Nordberg®

A Nordberg Group Company

Mine Hoists



SINCE 1895...EXCELLENCE IN HOISTING EQUIPMENT

Satisfied customers all over the world attest to the safety, operational economy and dependability of hoisting equipment engineered for the job by Nordberg.

NORDBERG'S HOISTING ENGINEERING SERVICE

In addition to building hoists for any tonnage, any depth Nordberg offers a unique engineering service. Our engineering staff will carefully analyze your hoisting problem and submit detailed recommendations. We'll provide the answer to a single question or recommend a complete system for maximum hoisting efficiency, including correlated shaft, conveyance, and hoist data.

GLOSSARY OF TERMS

Brake Priming is used with automatic or semi-automatic control. When the hoist is approaching a stop, it slows down to a creep speed. During this creeping, the clearance is removed between the brake shoes and the brake wheel. When the final stop signal is given, accurate spotting can be attained since the brakes are already partially applied.

Coefficient of Friction has particular importance when referring to Friction Hoists since it refers to the driving friction developed between the hoist rope or ropes and the friction tread material mounted on the hoist. Since the hard wires of the rope actually imbed themselves in the softer friction material, it is sometimes referred to as the "Coefficient of Grip". Many types of materials have been used for the friction treads - wood, leather, rubber and plastic. The allowable coefficients of friction and bearing pressure will vary with the type of friction material and size of rope and wheel used.

Controls: Automatic — Usually on a production hoist. With this type of control, a skip is spotted at the loading pocket and the cycle is initiated by a pushbutton. The hoist will then load, run and unload continuously until a stop signal is given.

Semi-Automatic - Similar to automatic control, except that the hoist stops at the end of each cycle and is then started again by pushbutton.

Manual - Requires a hoist operator at all times. He manually regulates the hoist speed via a master switch. Automatic and semi-automatic hoists also have provisions for manual control.

Creep (Rope) applies to Friction Hoists and describes the action of the rope or ropes actually creeping over the drum in the direction of rotation. This is caused by the ropes being stretched by the load on the high tension side and passing over the drum to a lower tension condition. This action is not to be confused with slip.

Drum Hoist is any hoist that has one end of the rope or ropes anchored to the drum and uses the drum for rope storage.

Friction Koepe Hoist is any hoist that uses the principle of friction to drive the rope.

GLOSSARY OF TERMS
(continued)

Koepe Wheel - Since the size of the drum on the Koepe hoist is considerably smaller either in width or diameter than the drum on a comparable drum hoist, it is sometimes referred to as a wheel.

Fleet Angle is the angle the rope makes with the drum as it deviates from perpendicular when winding across the drum. This angle should never exceed 1-1/2°. For multilayer winding the minimum is 0°30'.

Rope Pull is a term very often used with two different meanings. Sometimes rope pull is defined as the load attached to the end of the rope, and sometimes as the rope pull at the drum (which includes the load attached to the rope as well as the weight of the rope itself). When using the term rope pull, the loads included should be specified.

Slip (Rope) occurs when the coefficient of friction or grip is not sufficient to supply the necessary driving or braking force on a friction hoist.

Slope Hoist is a particular type of drum hoist usually associated with an unbalanced rope pull on an incline.

Synchronizer - Every Koepe Hoist requires a synchronizer. Since the rope or ropes are not fastened directly to the drum, it is possible to have relative movement between the drum and rope, such as creep or slip, which puts the indicating devices out of adjustment. With the hoist at rest the synchronizer may be adjusted manually or automatically to correct the indicating and safety devices.

Tension Ratio $\frac{T_1}{T_2}$ ratio is the ratio of the heavier side rope tension (T_1) to the lighter side rope tension (T2). This is a consideration only with friction hoists.

SINGLE DRUM HOIST

As a service or production hoist with cage or skip in balance with a counterweight, a single drum hoist can efficiently service one or more levels, since the location of the counterweight at any time is not important. As a production hoist with skips in balance, the single drum hoist is best used for single level hoisting. When this hoist is used as a multi-level production hoist, ship re-spotting is required, and hoisting efficiencies are reduced. In fact, more production can be obtained from the lower level since respotting is required for the upper level. With this situation, consideration is given to dropping all material to the lower level. All rope adjustments for proper spotting must be done manually for the single drum hoist.

DIVIDED SINGLE DRUM HOIST

If multi-layer winding is necessary, the single drum hoist must have a divider to allow a separate compartment for each rope. If a counterweight is used with a divided drum application, the counterweight rope can be wound on a smaller diameter. Consequently, the counterweight moves a lesser distance than the main conveyance, and rope adjustment problems are reduced.

DOUBLE DRUM HOIST - ONE DRUM CLUTCHED

As a service hoist with cage and counterweight, this hoist can serve several levels efficiently, the clutch facilitating quick adjustment of ropes to compensate for initial stretch. This hoist is also used occasionally as a production hoist with skips in balance for one-level hoisting. In both the above cases, the selection of this hoist over a single drum hoist would be justified only when the added expense of the second drum and clutch would be offset by savings in rope adjustment time. When this hoist is used as a production hoist with skips in balance for a multi-level operation, the clutch can be adjusted for efficient hoisting from any level.

DOUBLE DRUM HOIST - BOTH DRUMS CLUTCHED

The main advantage claimed for this type of hoist is that if something happens in one of the two compartments, the hoist can operate in the other compartment to raise and lower men and supplies. This hoist arrangement is particularly favored if there is only one shaft entrance to the mine.

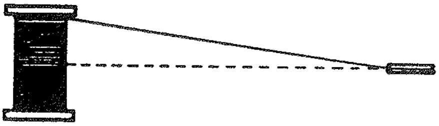
KOEPE HOIST

Single and Multi-Rope Koepe Hoists can be efficient as service hoists with cage and counterweight for single or multi-level hoisting or as production hoists with skip and counterweight for single or multi-level hoisting. They can also be efficient as production hoists for single level hoisting with skips in balance.

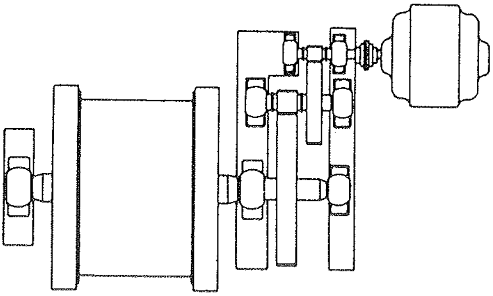
ESCAPE HOIST

Escape hoists are used under emergency conditions only to remove men from the mine. Controls are manual with an unbalanced load.

HOIST TYPES

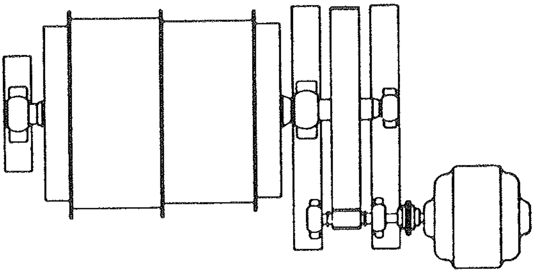


FLEET ANGLE

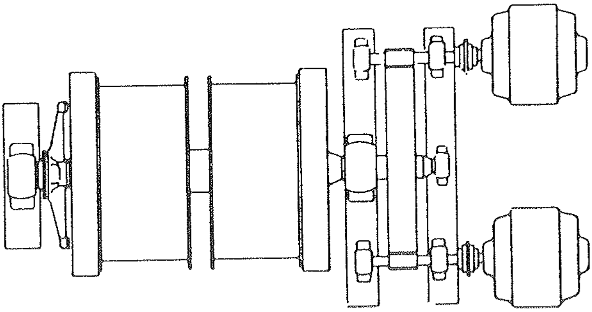


SINGLE DRUM HOIST

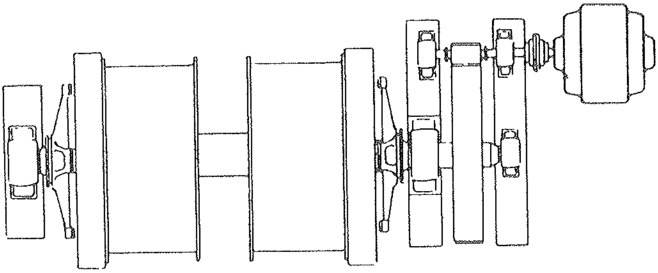
HOIST TYPES
(continued)



DIVIDED SINGLE DRUM HOIST

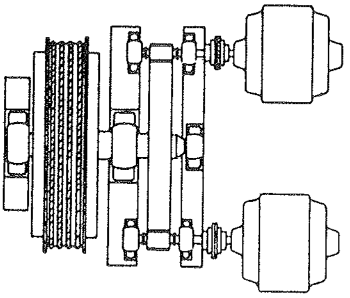


DOUBLE DRUM HOIST — ONE DRUM CLUTCHED



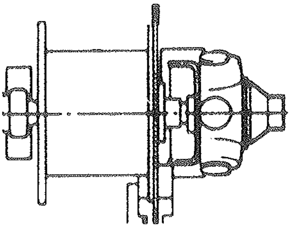
DOUBLE DRUM HOIST — BOTH DRUMS CLUTCHED

HOIST TYPES
(continued)



KOEPE HOIST

The number of motors varies with the horsepower required. When the gear size for one motor is excessive, two motors are used. Generally with the gear set kept at a reasonable size, (12:1 ratio or less), and the horsepower 1500 or less, one motor is less expensive than two. If the ratio exceeds 12:1, double reduction gearing is usually employed.



ESCAPE HOIST

18-7 MINE HOISTS

The following table shows the types of hoists that can be efficiently used for some of the more general conditions of vertical shafts. These could also apply to slope shafts except for the Koepe Friction Hoists. Koepe hoists have been used on slopes, but this is the rare exception rather than the rule.

CONDITION	DRUM HOIST	KOEPE HOIST
(1) Cage and Counterweight Skip and Counterweight Single or Multi-Level	*Single Drum	Single Wheel
(2) Skip and Skip Single Level	*Single Drum	Single Wheel
(3) Skip and Skip Multi-Level	Double Drum Clutched	Two Wheels (Skip and Counterweight Each)

* Some mine operators prefer a double drum hoist with one or two clutches for conditions 1 and 2, to have additional flexibility for rope adjustments and rope changing. The hoist cost is, of course, greater and must be compared with the operational advantages.

DRUM GROOVING

There are four types of drum grooving: Helical, Parallel, Counterbalance and Anti-Synchronous.

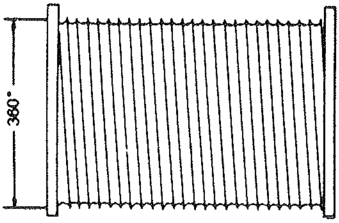
Helical grooving is a continuous spiral giving very smooth winding with a single layer of rope. It has also been used with multi-layer windings.

Parallel grooving is made up of individual grooves evenly spaced over the drum width. This grooving is used for single layer winding. It is never used for multi-layer winding since the wire rope must cross the crest of the groove to get from one groove to the next. This grooving is no longer recommended for new drums.

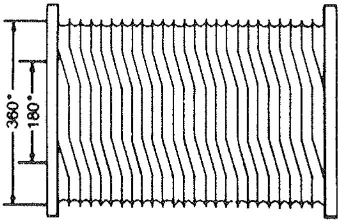
Counterbalance (Lebus) grooving is a combination of parallel and helical. The Counterbalance groove travels parallel for one half turn of the drum and then pitches over just *one half* of the groove width. It continues parallel for the other half turn of the drum and then pitches over the other half of the groove width. With this groove and multi-layer winding, the rope pitches over just half as much at the crossover points as it does with multi-layer windings on helical and parallel grooves. This type of grooving is most desirable for high speed multi-layer winding since it reduces rope whip at the crossover.

Anti-Synchronous grooving same as Counterbalance spooling except the crossover sections are 150 degrees and 210 degrees apart rather than 180 degrees or some combination of degrees adding up to 360 degrees.

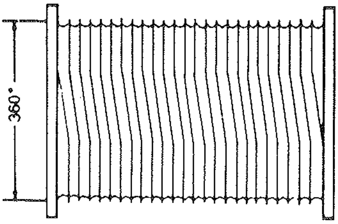
DRUM GROOVING



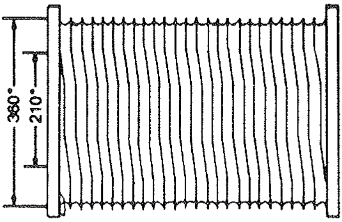
HELICAL GROOVING



COUNTERBALANCE GROOVING



PARALLEL GROOVING
(single crossover)



ANTI-SYNCHRONOUS GROOVING

BRAKING SYSTEMS

Mine Hoist Brakes - The hoist brakes are probably the most important part of hoist design. The three main types of brakes are the jaw and parallel motion types, and disc types. All three types have variations. It is important with any brake that the braking surfaces apply to the brake path with a uniform pressure or motion. Nordberg jaw brakes give the same even shoe wear as parallel motion brakes, and should always be given first consideration because of their greater simplicity.

Brake Control and Safety - There are various brake control schemes using either air or hydraulics as a control medium. A gravity backup system is a law in most areas. Springs, however, have also been used to back up the brake control system should all power fail.

The simplest system is to use a cylinder which raises or lowers a weight on the brake lever. Either oil or air can be used in the cylinder and only on one side of the piston. Air is generally used in this sort of system when the brakes are only required to be "on" or "off". Because of air compressibility, controlled braking with an air system requires air pressure on both sides of the piston or some sort of auxiliary hydraulic mechanism.

On automatic hoists the brakes are required to prime just before stopping. Priming puts a predetermined amount of braking on the hoist during the last few feet of creep, so that when the final stop signal is given, final braking is fast and spotting accurate. Repetitive accuracy is extremely important.

BRAKING SYSTEMS
(continued)

The following are the available braking schemes:

1. Gravity Primed, Gravity Applied, Pressure Released. (hydraulic)

2. Pressure Primed, Pressure Applied, Pressure Released with Gravity Backup. (air or hydraulic)

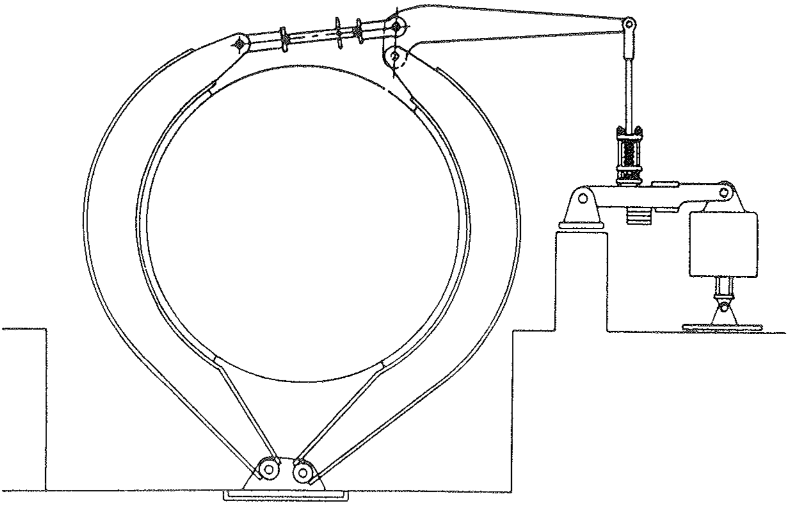
3. Pressure Released, Spring Applied (hydraulic disc type)

All of these systems fulfill the necessary braking requirements and have been used on Nordberg Hoists.

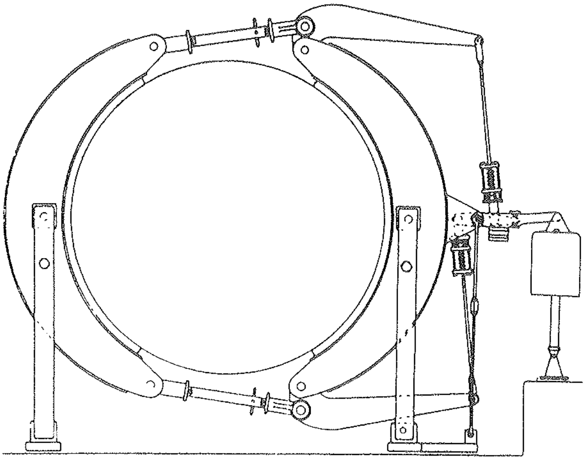
Emergency Braking - Bringing the hoist to a controlled, smooth stop after a total power failure is the most important brake function. This has not been a problem for drum hoists at depths to approximately 3000 feet, nor is it a problem with Koepe hoists where the system is either in balance when empty or maximum out of balance when loaded. On a double drum hoist at depths below 3000 feet, however, the rope weight and conveyance, whether loaded or empty, can create such a wide variance of braking requirements that a more sophisticated brake control is required.

There are several emergency braking arrangements available: varying braking pressure with depth and/or hoisting direction; firing off a sequence of valves applying braking as needed according to a feedback rate; setting the brake rapidly until the feedback system dictates that rate must be held until stopping.

BRAKING SYSTEMS



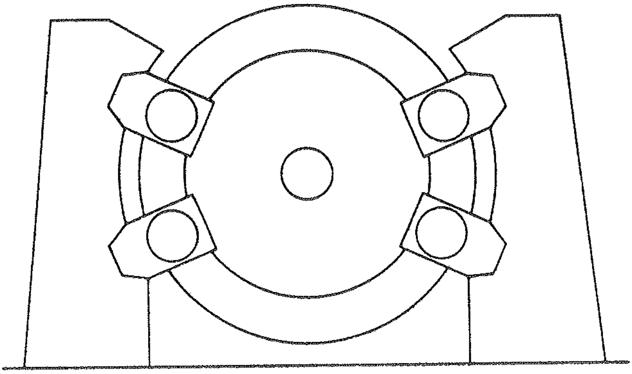
NORDBERG UNIFORM PRESSURE
HYDRAULIC JAW BREAKER



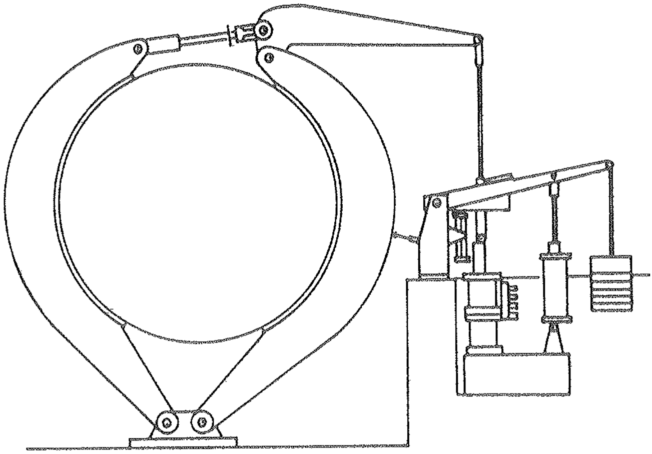
NORDBERG PARALLEL
MOTION BRAKE

18-11 MINE HOISTS

The unique Nordberg jaw brake features a pivot which is located lower than that on an ordinary jaw brake. This eliminates uneven lining wear by achieving the same uniform braking pressure which a parallel motion brake provides. Nordberg jaw brakes require only one adjustment.



DISC
BRAKE



UNIFORM
PRESSURE PNEUMATIC
JAW BRAKE

GENERAL WIRE ROPE DATA

	ROUND STRAND			FLATTENED STRAND			LOCKED COIL		
	6 x 9 Class Improved Plow Steel			6 x 7 Type H, 6 x 30 Type G			Improved Plow Steel		
		Braking Strength in Tons of 2000 Lbs.			Braking Strength in Tons of 2000 Lbs.			Braking Strength	
Dia. (mm)	Wgt. (Kgs/Meter)	Normal	High	Wgt. (Kgs/Meter)	Normal	High	Wgt. (Kgs/Meter)	in Tons of 2000 Lbs.	Dia. (mm)
3/4" (19.1)	.95 (1.4)	23.8	26.2	1.01 (1.5)	26.2	28.8	1.37 (2.0)	35.0	3/4" (19.1)
7/8" (22.2)	1.29 (1.9)	32.2	35.4	1.39 (2.1)	35.4	39.0	1.87 (2.8)	46.0	7/8" (22.2)
1" (25.4)	1.68 (2.5)	41.8	46.0	1.80 (2.7)	46.0	50.6	2.43 (3.6)	61.6	1" (25.4)
1-1/8" (28.6)	2.13 (3.2)	52.6	57.9	2.28 (3.4)	57.9	63.7	3.30 (5.0)	76.1	1-1/8" (28.6)
1-1/4" (31.8)	2.63 (3.9)	64.6	71.0	2.81 (4.2)	71.0	78.1	3.76 (5.6)	92.0	1-1/4" (31.8)
1-3/8" (35.0)	3.18 (4.7)	77.7	85.4	3.40 (5.1)	85.5	94.0	4.78 (7.1)	115.0	1-3/8" (35.0)
1-1/2" (38.1)	3.78 (5.6)	92.0	101.0	4.05 (6.0)	101.0	111.0	5.65 (8.4)	135.0	1-1/2" (38.1)
1-5/8" (41.3)	4.44 (6.6)	107.0	118.0	4.75 (7.1)	118.0	130.0	6.88 (10.2)	155.0	1-5/8" (41.3)
1-3/4" (44.5)	5.15 (7.7)	124.0	136.0	5.51 (8.2)	136.0	150.0	7.56 (11.2)	182.0	1-3/4" (44.5)
1-7/8" (47.6)	5.91 (8.8)	141.0	155.0	6.33 (9.4)	155.0	171.0	9.00 (13.4)	212.0	1-7/8" (47.6)
2" (50.8)	6.72 (10.0)	160.0	176.0	7.20 (10.7)	176.0	191.0	9.77 (15.0)	240.0	2" (50.8)
2-1/8" (54.0)	7.59 (11.3)	179.0	197.0	8.13 (12.1)		215.0			2-1/8" (54.0)
2-1/4" (57.2)	8.51 (12.7)	200.0	220.0	9.10 (13.5)		240.0			2-1/4" (57.2)

For applications of larger diameter hoist ropes than shown consult Nordberg. There also are higher strength ropes available, but the above will serve as a guide.

Nordberg recommends a minimum drum diameter (D) to rope diameter (d) ratio of 60 for slope hoists and hoists using a rope less than 1 inch in diameter. For rope diameter 1 inch and above a D/d of 80 minimum and 100 for all locked coil rope.

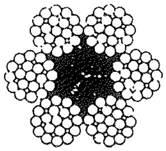
SAFETY FACTORS FOR DRUM HOISTING

(When Handling Men)

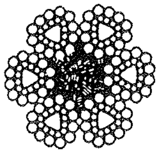
LENGTH OF ROPE IN SHAFT (FT.)	METERS METERS	MIN. FACTOR OF SAFETY NEW ROPE.
500 or less	152.0 or less	8
501 to 1000	152.3 to 304	7
1001 to 2000	304.3 to 608	6
2001 to 3000	608.3 to 912	5
3001 and over	912.3 and over	4

Note: Based on total static (dead weight) load. In some states this table is written into the mining laws and must be used accordingly.

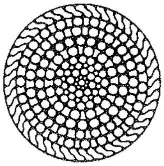
Shown below are some of the various types of wire ropes that are used in mine hoisting.



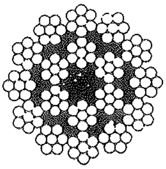
ROUND STRAND HOISTING ROPE



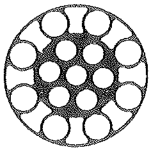
FLATTENED STRAND HOISTING ROPE



LOCKED COIL HOISTING ROPE



NON-ROTATING TAIL OR BALANCE ROPE



HALF LOCK SHAFT GUIDE ROPE

There are many variables which affect the selection of the most economical hoisting system, and it would be extremely difficult to cover all of them in a handbook. The following steps, however, will serve as a guide in selecting a hoist for a given condition. Although the following method was developed for vertical hoisting, the same general principles apply to slope hoists. For slope hoist calculations assume rolling friction to be 2.5% and the rope friction factor to be 10%. (These percentages vary with the degree of slope, but the ones given will serve as a general guide.)

HOW TO SELECT A HOIST

Given: Desired capacity (TPH) and depth for vertical shaft.

Find: Skip load, and wire rope sizes, hoist size and motor horsepower.

The main problem in selecting a hoist for a given capacity and depth is deciding on the proper skip load (payload). A larger load hoisted at slower speeds requires less horsepower, but at the expense of increased rope diameter which, in turn, increases the drum diameter, gearing, etc. In selecting a skip size, therefore, it is helpful to know the relationship between skip load, speed, and capacity for the given depth. Such a relationship is shown in Graph A. These curves show that for any capacity, as skip load decreases, the speed increases to the point where the cycle consists of only acceleration and retardation, with no full speed time (approximately 63 f.p.s. at 1600 ft. in Graph A).

To Find Skip Load: Use this equation:[1]

$$\text{SL (in tons)} = \frac{\dfrac{\text{depth (in ft.)}}{\text{velocity (f.p.s.)}} + 0.4\,\text{velocity} + 12}{\dfrac{3600}{\text{capacity (TPH)}}}$$

By substituting depth and capacity values, assuming different velocities, and solving for skip load, plot a skip load-velocity curve similar to those in Graph A.

[1] Derived as follows:

$$\text{cycle time (CT)} = \frac{3600}{\text{TPH}} \times \text{skip load (SL) in hours}$$

running time (RT) = CT − rest (in sec.) rest = creep time + idle time

$$RT = \frac{3600 \times SL}{TPH} - \text{rest}$$

$$\text{and also } RT = \frac{\text{depth}}{\text{velocity (V) (f.p.s.)}} + \frac{V}{2}\left(\frac{1}{\text{acceleration rate (a)}} + \frac{1}{\text{retard rate (r)}}\right)$$

Assume creep and rest time to be 12 seconds total, and a and r rates to be 2.5 f.p.s.^{2} and the equations reduce to

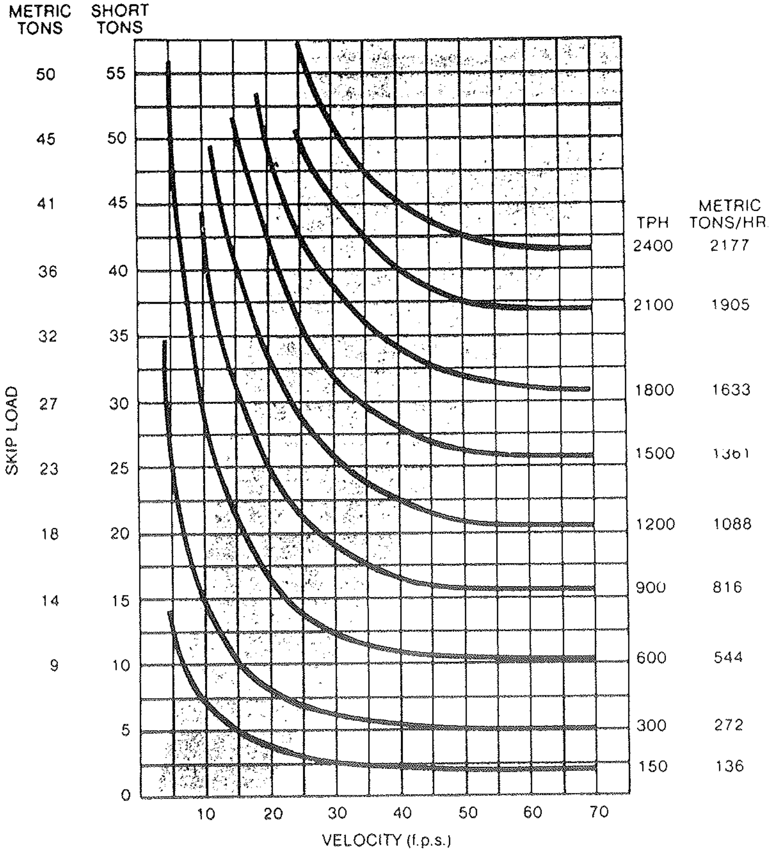
$$RT = \frac{3600}{TPH} \times SL - 12 \qquad RT = \frac{\text{depth}}{V} + 0.4V$$

$$\text{Equating } \frac{3600}{TPH} \times SL - 12 = \frac{\text{depth}}{V} + 0.4V \text{ or } SL = \frac{\dfrac{\text{depth}}{V} + 0.4V + 12}{\dfrac{3600}{TPH}}$$

If the rest, creep, acceleration and retard rates are known, these should be used, rather than the above figures.

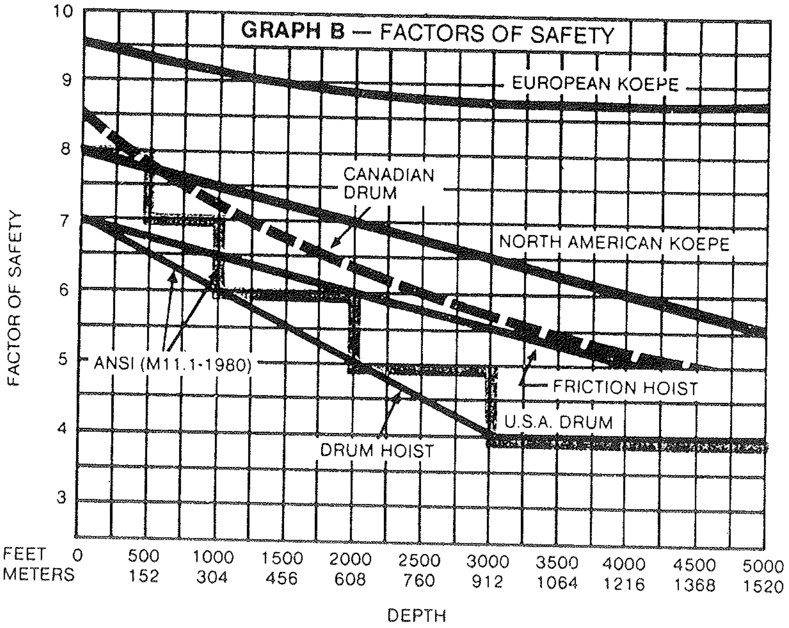
HOW TO SELECT A HOIST
(continued)

GRAPH A - SKIP LOAD/VELOCITY CURVES FOR 1600 FT. (486M) DEPTH



NOTE: SKIPS IN BALANCE

HOW TO SELECT A HOIST
(continued)



ROPE TYPE	K_1	K_2
Round Strand	41.8	0.00084
Flattened Strand	46.0	0.00090
Locked Coil	61.6	0.00122

These six curves represent the factor of safety laws or standards for drum and friction hoists in the United States, Canada, and a European country. These curves are shown to point out the wide variations which indicate that rope factors of safety are not easily established, absolute values. The step curve is the M S H A minimum allowable when men are being hoisted. The ANSI (M11.1 - 1980) curves are that standard's requirement for drum hoisting and Koepe hoisting considering the maximum load only for men or material. Some states have laws that are more rigid, and the various regulations change from time to time. The factors of safety shown should be used as a guide only and the laws in each area should be checked. A high factor of safety is no substitute for a good inspection and maintenance program.

HOW TO SELECT A HOIST
(continued)

The next step is to select the proper skip load. The left side of the shaded area of Graph A indicates the portions of the curves optimum for Koepe Friction Hoists; the right side shows portions optimum for drum hoists. (Experience has shown that the optimum skip load of a Koepe Friction Hoist usually is larger than that of a drum hoist, for the same tonnage and hoisting depth. By increasing the skip load, it is sometimes possible to jump to the next smallest motor size without greatly increasing the cost of the mechanical equipment. With a drum hoist, the cost of the mechanicals increases more rapidly than with a friction hoist - hence the different optimum areas.)[2]

From the curve you have constructed, select the proper skip load. Multiply this skip load by .75 to find an approximate skip weight [SW (skip weight) = .75 SL].[3]

(Consult Graph B to determine Kl and K2 and factor of safety.)

To Find Rope Size: Solve this equation for diameter:

$$\text{diameter (d)} = \sqrt{\frac{\dfrac{\text{skip load (tons)} + \text{skip weight (tons)}}{\dfrac{K_1}{\text{factor of safety}} - K_2 \times \text{depth}}}{\text{number of ropes}}}$$

[2]The cost of the headframe, skips, loading pockets and ropes enters into the economics when selecting skip loads, but these cost changes are relatively small. (Skip sizes can be varied within limits without changing the shaft section.) We are not attempting to make an economic comparison between drum and Koepe schemes in this manual - to select one over the other involves a complex study which should include the complete hoisting plants.

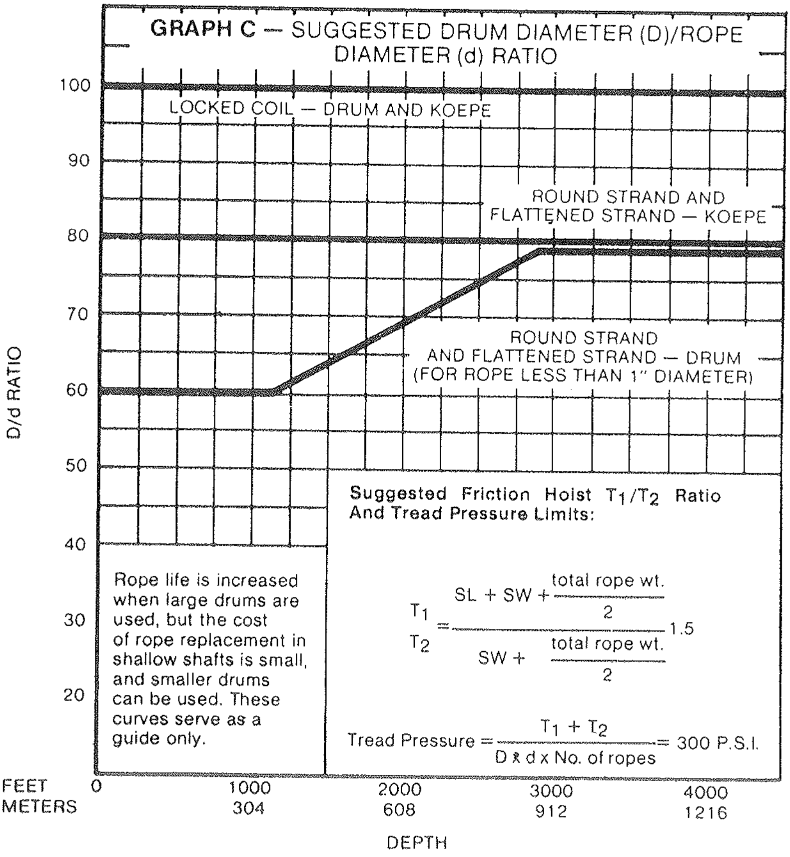
[3]If your skip weight factor is known, use it rather than 0.75. To determine proper friction hoist skip weight, see Graph C.

[4]Derived as follows:

Braking strength of rope (in tons) =
[SL + SW + (wt./ft. of rope x depth)] factor of safety

Expressed in terms of rope diameter, using constants K_1 and K_2, this becomes $K_1 d^2 = (SL + K_2 \times \text{depth} \times d^2)$ factor of safety.

HOW TO SELECT A HOIST
(continued)



GRAPH C — SUGGESTED DRUM DIAMETER (D)/ROPE DIAMETER (d) RATIO

To Find Drum Diameter: Consult Graph C and determine the proper D/d ratio number for your hoisting depth. Multiply rope diameter (d) by this number to determine drum diameter (D). Graph C also gives suggested friction hoist T_1/T_2 ratio and tread pressure limits.

To Find Face Width of Drum Hoist: Select a standard rope diameter corresponding to d. Then solve one of the following equations for face width:

For Single Drum: (balanced hoisting, single layer)

$$\text{face width (inches)} = \frac{S \times \text{depth}}{D} + 15S$$

For Double Drum: (single layer)

[S = groove pitch (approximately 1.05d)]

$$\text{face width (inches)} = \frac{S \times \text{depth}}{D} + 7S$$

HOW TO SELECT A HOIST
(continued)

[For each additional layer of rope, eliminate the dead turns (15S or 7S) and increase D by 1.7d.]

To Find Motor Horsepower: RMS (HP)

Draw a h.p./time cycle diagram similar to Diagram E or Diagram F and label it.

ta = acceleration time (sec.)

tfs = full speed time (sec.)

tr = retardation time (sec.)

For estimating purposes and simplification, combine Ta_1 and Ta_2 = ta, and tr_1 and tr_2 = tr. Creep time is not considered in acceleration or retard time.

From your skip load velocity corresponding to the skip load.

Knowing the velocity, and assuming 2.5 f.p.s. for a and r rates, find ta and tr.

$$ta = tr = \frac{V}{2.5}$$

RMS HP for Drum Hoist

Find the approximate equivalent effective weight (EEW) on Graph D.

Using the following steps[5], determine h.p. values corresponding to various points in h.p./time cycle Diagram E.

$$HP_1 = \frac{TSL \times V^2}{32.2 \times ta \times 550}$$

$$HP_2 = \frac{TSL \times V^2}{32.2 \times tr \times 550}$$

$$HP_3 = \frac{(SL + R) \times V}{550}$$

$$HP_4 = \frac{SLB \times V}{550}$$

$$HP_5 = \frac{SLT \times V}{550}$$

$$HP_6 = \frac{(SL\text{-}R) \times V}{550}$$

$$HP_7 = \frac{SL \times V}{550} \times .176$$

[5](Explanations of the abbreviations used in the drum horsepower equations which follow:)

R = depth x rope weight per ft.

TSL = total suspended load = EEW + SL + 2SW +2R

SLB = suspended load at bottom of shaft = (SL + R) - (V x ta x rope wt. per ft.)

SLT = suspended load at top of shaft = (SL - R) + (V x tr x rope wt. per ft.)

[6] $.176 = \frac{100 - E}{E}$ E = 0.85

[7]rest = creep time + idle time

HOW TO SELECT A HOIST
(continued)

A. (peak accelerating h.p.) $= HP_1 + HP_7 = \dfrac{HP_4 + 2HP_3}{3}$

B. (full speed h.p. at end of acceleration period) $= HP_4 + HP_7$

C. (full speed h.p. at start of retard period) $= HP_5 + HP_7$

D. (retardation h.p.) $= HP_2 + HP_7 + \dfrac{HP_5 + 2HP_6}{3}$

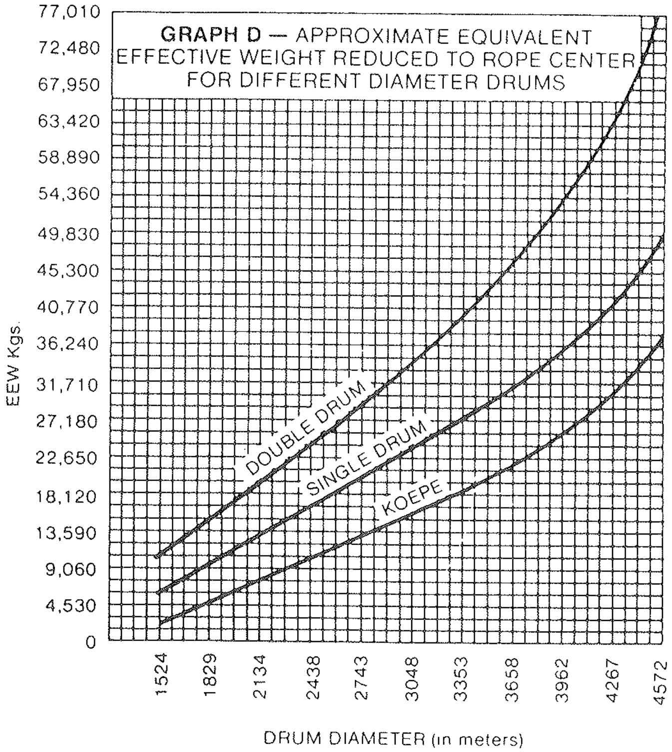
HP_8 (h.p. required to accelerate motor rotor) $= \dfrac{0.6A \times 1.2}{ta}$

HP_9 (h.p. required to retard motor rotor) $= -\dfrac{0.6A \times 1.2}{tr}$

E. (total h.p. required to accelerate hoist and motor) $= A + HP_8$

F. (total h.p. required to retard hoist and motor) $= D + HP_9$

Note - HP_2 and HP_9 are negative



HOW TO SELECT A HOIST
(continued)

Finally, calculate Root Mean Square Horsepower (RMS HP) for d.c. motor:

$$*\text{RMS HP} = \sqrt{\frac{E^2 \times ta + \frac{B^2 + C^2 + BC}{3} tfs + F^2 \times tr}{.75ta + tfs + .75tr + .5\text{ rest}}}$$

for induction motor:

$$*\text{RMS HP} = \sqrt{\frac{E^2 \times ta + \frac{B^2 + C^2 + BC}{3} tfs + F^2 \times tr}{.5ta + tfs + .5tr + .25\text{ rest}}}$$

*For self ventilated motors.

On forced ventilated motors use total cycle time.

RMS HP For Friction Hoist

Find the appropriate EEW on Graph D.

R = depth x rope weight per ft. x 2 no. of ropes

EEW + SL + 2SW + R = TSL

$$HP_1 = \frac{TSL \times V^2}{32.2 \times ta \times 550} \qquad HP_3 = \frac{SLT \times V}{550}$$

$$HP_2 = \frac{TSL \times V^2}{32.2 \times tr \times 550} \qquad HP_4 = \frac{(SL\text{-}R) \times V}{550} \times .111$$

Using the following steps, determine horsepower values corresponding to various points in h.p./time cycle Diagram F.

A. (peak acceleration h.p.) = HP_3 HP_4 + HP_1

B. (full speed h.p.) = HP_3 + HP_4

C. (total retardation h.p.) = HP_3 + HP_4 + HP_2

HP_5 (h.p. required to accelerate motor rotor) $= \dfrac{.75A \times 1.2}{ta}$

HP_6 (h.p. required to retard motor rotor) $= \dfrac{.75A \times 1.2}{tr}$

D. (total h.p. required to accelerate hoist and motor) = A + HP_5

E. (total h.p. required to retard hoist and motor) = C + HP_6

Note - HP_2 and HP_6 are negative

HOW TO SELECT A HOIST
(continued)

Finally, calculate Root Mean Square Horsepower (RMS HP) for d.c. motor:

$$^{*}\text{RMS HP} = \sqrt{\frac{D^2 \times ta + B^2 \times tfs + E^2 \times tr}{.75ta + tfs + .75tr + .5\ rest}}$$

for induction motor:

$$^{*}\text{RMS HP} = \sqrt{\frac{D^2 \times ta + B^2 \times tfs + E^2 \times tr}{.5ta + tfs + .5tr + .25\ rest}}$$

*For self ventilated motors.

On forced ventilated motors use total cycle time.

DIAGRAM E — H.P./TIME CYCLE
(Drum Hoist)

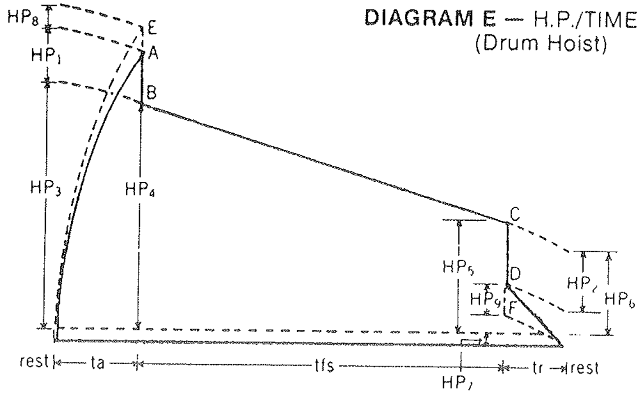
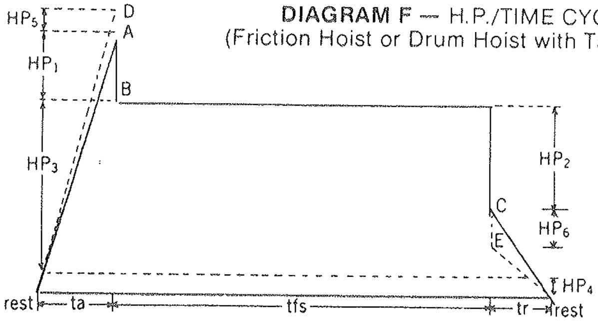


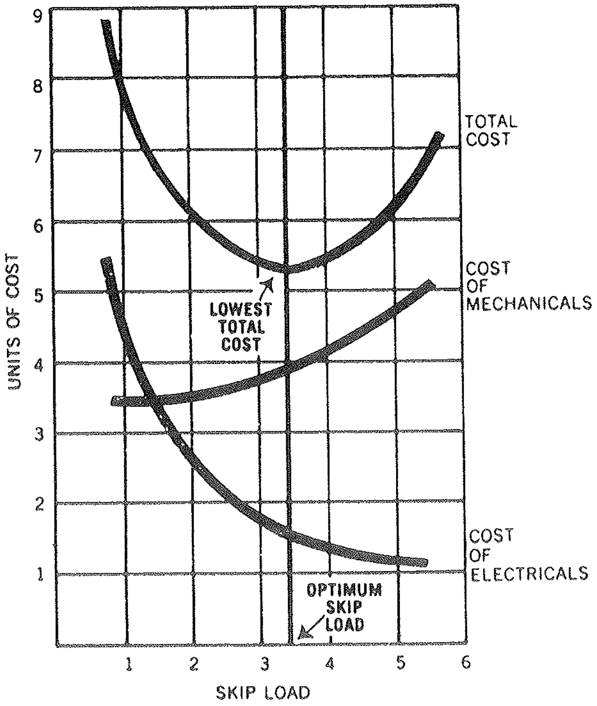
DIAGRAM F — H.P./TIME CYCLE
(Friction Hoist or Drum Hoist with Tail Rope)



HOW TO SELECT A HOIST
(continued)

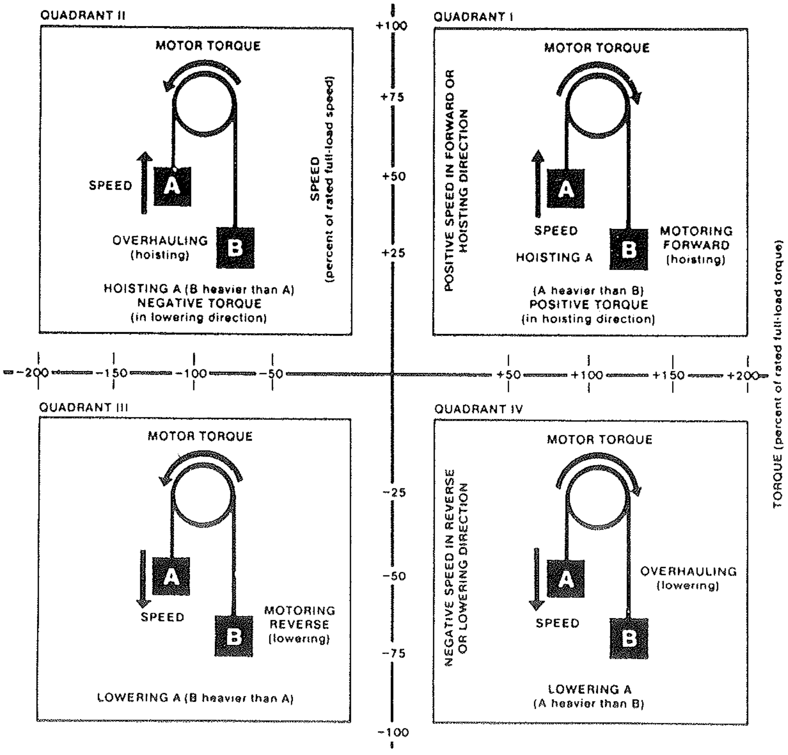
The shaded area In Graph A on Page 18-14 indicates the approximate economical limits for a given condition. Picking a skip load and speed from a similar skip load/velocity curve is certainly sufficient for general planning. The accompanying graph shows, however, that to obtain the optimum load and speed actual cost curves should be plotted. Nordberg engineers plot similar curves before making any hoisting system recommendations.

FOR A GIVEN DEPTH AND CAPACITY, THERE IS AN OPTIMUM LOAD



HOIST DRIVES

Four Quadrants of Hoist Operation



Most mine hoist drive systems require "four Quadrant" operation. The four quadrants represent motoring in hoisting and lowering and overhauling in hoisting and lowering. When motoring the hoist drives a mechanical load in the direction of rotation, when overhauling energy is returned to the system.

HOIST DRIVES
(continued)

Hoist drives supplied with THYRISTOR CONVERTERS offer all the features which are required to make the Modern Hoisting Plant EFFICIENT and RELIABLE.

Static Variable Speed Hoist Drives can be supplied with either DC DRIVE technology or AC DRIVE technology as required. The DC technology uses DC POWER CONVERTERS to control the power to DC motors to achieve speed control. The AC technology also uses DC POWER CONVERTERS to deliver controlled low frequency AC power to an AC Synchronous Motor. By varying the motor frequency, speed control is achieved. This type of drive is called an AC CYCLOCONVERTER.

Both the DC and AC STATIC DRIVE offer:

- HIGH EFFICIENCY
- HIGH RELIABILITY
- DIGITAL TECHNOLOGY
- REDUCED MAINTENANCE
- SUPERIOR DIAGNOSTICS
- BETTER PERFORMANCE

This means more AVAILABLE TIME for the Hoist to do the job it was intended for "DELIVER ORE TO THE MILL".

NORDBERG and its DRIVE SUPPLIER are prepared to work with their customers to select the DRIVE TECHNOLOGY which not only meets the APPLICATION, but also meets both the PRIMARY and the LONG TERM OBJECTIVES.

DC MACHINES

There Are At Least Three Modes Of Operation With Automatic Hoists

1. Automatic (production only), with the skip (s) correctly spotted; the cycle is initiated and will continue operating unattended until stopped.

2. Semi-automatic, with the conveyance (skip or cage) currently spotted; the cycle is initiated by pushbutton. The conveyance goes to the selected level under control of the programmer and stops.

3. Manual control is from the master switch, with the programmer still overriding acceleration and deceleration rates. The hoist brakes are normally interlocked with the master switch and applied when the switch is moved to the zero-speed position.

To these may be added:

4. Shaft or rope inspection speed - speed is limited to 100 to 200 ft./min. regardless of position of controller.

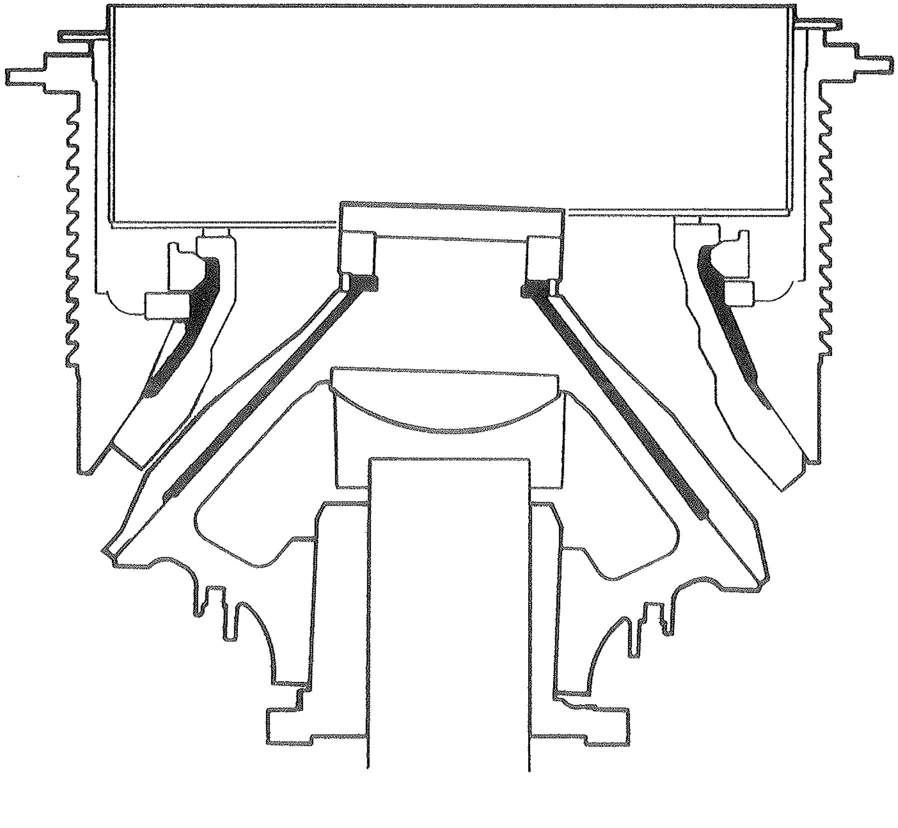
5. Test - a single trip of the conveyance initiated from the control panel.

At each level control panel a"jog up" "jog down" button provides creep speed within range of that level.

Nordberg®

A Nordberg Group Company

Backing Material



NORDBAK BACKING MATERIAL

A 100% Solids Epoxy System. Nordbak Backing Material is the Easy, Safe and Positive way to back wear metal in all types of crushers and grinding mills.

Easy - because all you do **is mix and pour.** No special training or experience is required.

Sate - because Nordbak is nonflammable and requires no melting or special pouring equipment. It is mixed in its own container and poured at room temperature, 60 F to 80 F.

Positive - because Nordbak provides 100% backing from the moment of hardening. Its volumetric stability eliminates the formation of gaps between backing and liners or support structures in crushers and mills.

Save time and money - just mix and pour. Continuing research and development by Nordbak chemists has resulted in a stronger Backing Material which combines the safety and durability of Nordbak with reduced viscosity and minimal filler settling. The result is easier mixing and handling characteristics and faster pouring. All designed to save you money.

Cut downtime. It fills even the smallest openings without leaving voids. The Backing Material has high compressive strength (15,500 psi) with a sufficient degree of flexibility for crusher or grinding mill use. Nordbak has been proved in thousands of applications throughout the world.

NORDBAK HIGH PERFORMANCE BACKING MATERIAL

High Performance Backing was formulated for use in 7' cone crushers. The High Performance formula provides higher impact strength than is required for normal applications. On the ASTM D-256-B Charpy Impact Test, High Performance Backing measures 2.7 ft. lbs./in. Backing Material, by comparison, measures 1.6 ft. lbs./in.

High Performance Backing exhibits excellent resilience while retaining high compression and tensile strengths. In all other respects (heat distortion temperature, ease of mixing and pouring) the High Performance formula is similar to Nordbak Backing Material.

Nordbak High Performance Backing has been used successfully on a number of installations where the Backing Material has broken up under severe conditions.

NORDBAK LOCKING COMPOUND

Nordbak Locking Compound
Locking Compound is a high temperature and high impact material for locking inner and outer eccentric bushings in Symons cone crushers. It is safe and easy to use. You save time and money with Locking Compound because all you do is **mix and pour** at room temperatures. No special training or experience is required.

One 6 lb. 4 oz. kit contains three ingredients: resin, filler, and hardener.

NORDBAK LOCKING COMPOUND
(continued)

When properly mixed, one kit provides 115 cubic inches of material. This is enough to lock the inner eccentric bushing on all sizes of Symons cone crushers and the outer eccentric bushing on all sizes except the 5-1/2' crushers. Two hits are needed to loch the outer eccentric bushings on Symons 5-1/2' Standard and Short Head cone crushers.

TYPICAL PROPERTIES OF NORDBAK BACKING MATERIAL, HIGH PERFORMANCE BACKING AND LOCKING COMPOUND

IMPACT: **Test Method** Charpy ASTM D-256-B	Backing Material High Performance Backing Locking Compound	1.6 FT.-Lbs./In. 2.7 FT.-Lbs./In. 3.0 FT.-Lbs./In.
COMPRESSIVE STRENGTH: **Test Method** ASTM D-695	Backing Material High Performance Backing Locking Compound	15,500 psi 21,000 psi 12,000 psi
TENSILE STRENGTH: **Test Method** ASTM D-638	Backing Material High Performance Backing Locking Compound	6,200 psi 8,500 psi 6,000 psi
GEL TIME: **Test Method** Modified SPI-ERF B-70	Backing Material High Performance Backing Locking Compound	20-25 minutes at 77°F 40-45 minutes at 77°F 30-40 minutes at 77°F
HEAT DISTORTION: **Test Method** 1 mil/10 mil ASTM D-648	Backing Material High Performance Backing Locking Compound	170°F 220°F 225°F
POURING VISCOSITY: **Test Method** Brookfield Viscometer	Backing Material High Performance Backing Locking Compound	16,000 cps at 77°F 20,000 cps at 77°F 14,000 cps at 77°F

TYPICAL PROPERTIES OF NORDBAK BACKING MATERIAL, HIGH PERFORMANCE BACKING AND LOCKING COMPOUND
(continued)

SHRINKAGE: **Test Method** ASTM D-2566	Backing Material High Performance Backing Locking Compound	.0015"/In. .0015"/In. .0018"/In.
SPECIFIC GRAVITY OF CURED MATERIAL: **Test Method** SPI-ERF 369	Backing Material High Performance Backing Locking Compound	1.7 1.7 1.5
WORKING TIME:	Backing Material High Performance Backing Locking Compound	10 minutes at 70°F 20 minutes at 70°F 10 minutes at 70°F

VOLUME OF MATERIAL:

2 Gallon (7.5 Liters) Backing Material, and High Performance Backing Kits contain 340 cubic inches (5572 cu. cms.) of cured material.

1 Gallon (3.78 Liters) locking Compound Kit contain 115 cubic inches (1884 cu. cms.) of cured material.

NUMBER OF 2-GALLON KITS OF NORDBAK BACKING MATERIAL AND HIGH PERFORMANCE BACKING REQUIRED FOR VARIOUS SIZES AND TYPES OF CRUSHERS

NORDBERG® PRIMARY GYRATORY CRUSHERS			
Crusher Size	HD 42-70	HD 54-80	HD 60-102
NUMBER OF HIGH PERFORMANCE BACKING KITS			
Concave	69	119	177
Mantle	24	39	49

SYMONS® CONE CRUSHER								
STANDARD CONE CRUSHER								
Crusher Size	2'	30"	3'	4'	4-1/4'	5'	5-1/2'	7'
NUMBER OF BACKING MATERIAL KITS								
Mantle	1	1	2-1/2	3-1/2	4	3-1/2	7-1/2	12
Bowl Liner	1	1	1-1/2	3-1/2	4-1/2	5	7-1/2	15

SYMONS® CONE CRUSHER								
SHORT HEAD® CONE CRUSHER								
Crusher Size	2'	30"	3'	4'	4-1/4'	5'	5-1/2'	7'
NUMBER OF BACKING MATERIAL KITS								
Mantle	1	--	1-1/2	--	2	2-1/2	3-1/2	6-1/2
Bowl Liner	1	--	1-1/2	--	2-1/2	5	6	9

Note: These figures are based on cone crushers with a fine bowl and fine liner. If other combinations are used without filler blocks, quantities could increase 40%.

TELSMITH GYRASPHERE[R] CRUSHER							
STYLE S							
Crusher Size	24	36"	367	48	489	66	6614
NUMBER OF BACKING MATERIAL KITS							
Mantle	1-1/2	2	2	4-1/2	4-1/2	9-1/2	9-1/2
Bowl Liner	1	1-3/4	1-3/4	1	4	11-1/2	17-1/2
STYLE FC							
NUMBER OF BACKING MATERIAL KITS							
Mantle	1-3/4	1-3/4	--	2	--	4	--
Bowl Liner	1	1-3/4	--	3-1/2	--	5-1/2	--

ALLIS-CHALMERS CRUSHERS										
SUPERIOR										
Crusher Size	16-50	24-60	30-55	36-55	30-70	36-55	42-65	48-74	54-74	60-89
NUMBER OF HIGH PERFORMANCE BACKING KITS										
Concaves	26	41	48	48	46	70	70	110	173	190
Mantle	17	18	16	14	24	27	27	46	46	66

ALLIS-CHALMERS CRUSHERS						
HYDROCONE						
Crusher Size	22	36	45	51	60	84
NUMBER OF HIGH IMPACT BACKING KITS						
Concaves	--	--	9	14	36	43
Mantle	--	1	10	5	6	22

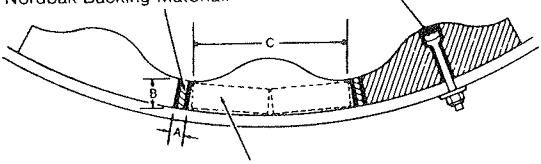
For all other crushers, simply divide the amount of metallic backing previously required by 88. The result is the number of 2 gallon its of Nordbak Backing Material required.

The above quantities are recommendations and may vary, in which case simply divide amount of metallic backing previously used by 88.

BACKING MILL LINERS

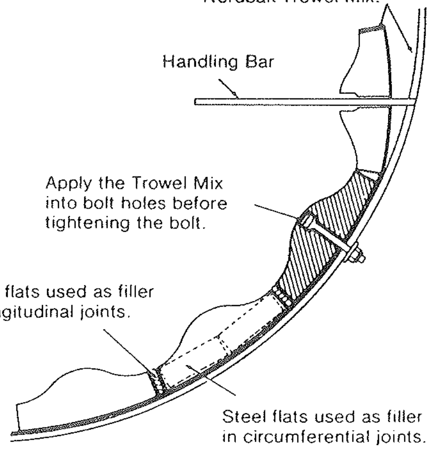
Nordbak Backing Material, when used as a mill liner backing material, will prevent shell erosion due to slurry or pulp racing, liner breakage because of non-uniform fit of the liner castings on the shell, and the loosening and shifting of liners during operation. It is being used successfully to back Nordite and Chrome-moly Castings in rod and ball mills used in the mining industry and raw and finish mills in the cement industry.

FIGURE 1



Nordbak Trowel Mix provides the same basic functions as the Backing Material. The paste-like Trowel Mix is applied to the back and bolt holes of new mill liners (see figure 2) before the bolts are inserted and tightened. It is also recommended for backing head liners, division heads, and diaphragms in all types of mills.

FIGURE 2



TYPICAL PROPERTIES OF BACKING MATERIAL AND TROWEL MIX

COMPRESSIVE STRENGTH: **Test Method** ASTM D-695	Backing Material Trowel Mix	15,500 psi 16,000 psi
TENSILE STRENGTH: **Test Method** ASTM D-638	Backing Material Trowel Mix	6,200 psi 4,000 psi
GEL TIME: **Test Method** Modified SPI-ERF B-70	Backing Material Trowel Mix	20-25 minutes at 77°F 15 minutes at 77°F
SPECIFIC GRAVITY OF CURED BACKING MATERIAL AND TROWEL MIX:		1.7
MEASURE:	2 Gallon (7.5 Liters) Backing Material Kit contains 340 cubic inches (5572 cu. cms.) of cured material. 2 Gallon (7.5 Liters) Trowel Mix Kit contains 470 cubic inches (7703 cu. cms.) of cured material.	
WORKING TIME:	Backing Material Trowel Mix	10 minutes at 70°F 15 minutes at 70°F

WEARING COMPOUND

This advanced material for armor surfacing all areas where solids or slurries cause abrasion is a unique composite of Nordbak Epoxy Resin, sapphire hard alumina ceramic beads, and silicon carbide. The beads take the abrasive wear. They are held securely in suspension, and to the surface to be treated, by the Epoxy Resin.

The trowelable material is easy to mix and apply on any surface and will conform to any shape such as cones, elbows, and other curved surfaces. Nordbak Wearing Compound cures fast and will have previously worn surfaces back in service quickly.

WEARING COMPOUND
(continued)

Following are specific benefits of Nordbak Wearing Compound which Maintenance Engineers welcome.

Laboratory tests, as noted on this page, show that Nordbak Wearing Compound is **eight times** more abrasive resistant than Ni-Hard iron - approaching that of ceramic tile. This means that Wearing Compound can be used in combination with ceramic tile, possibly eliminating the need for costly custom shapes. Wearing Compound is chemically resistant to water, solvents, most acids, and basic materials. It also acts as a corrosion inhibiting coating to arrest rusting.

FEATURE	BENEFIT
Just Mix and Trowel	Save downtime. Armor surfacing can be completed during normal maintenance shutdown without loss of production.
Quickly Conforms to Desired Shape	Saves labor and time. Permits repairs usually without replacement of wear parts.
Sapphire Hard	Extended wear life reduces maintenance frequency and need for extensive wear parts inventory.
Easy, Fast, Safe to Apply	Labor and material costs are further reduced by comparison to rubber or tile linings. No special skills are required for application.

USE IT WHEREVER HIGH WEAR RETARDS PRODUCTION AND BOOSTS COSTS:

- Return Idlers
- Feed Chutes and Boxes
- Rod and Ball Mills
- Repair Pump Castings
- Feed Plates
- Conveyor Skirts
- Dust Collectors and Cyclones
- Soil and Rock Box Outlets
- Launder Chutes
- Slurry Line Elbows
- Vibrating Screens
- Flumes and Troughs
- Grit Chambers
- Fans and Housings
- Silos
- Abrasive Cleaning Equipment
- Chute Linings
- Drag Line Pulleys
- Feed Chutes
- Pipe Elbows
- Pan Feeders
- Buckets
- Hoppers
- Classifier Flights and Shoes
- Repulp Water Circulators
- Tanks
- Scrubbers
- Pipe Transitions
- Heavy Media Vessels
- Exhausters
- Coal Mills
- Mixing Equipment

TYPICAL PROPERTIES OF NORDBAK WEARING COMPOUND AND STEEL TROWEL MIX

	Wearing Compound	Steel Trowel Mix
TENSILE STRENGTH: **Test Method** ASTM D-638	5,000 psi	5,500 psi
COMPRESSIVE STRENGTH: **Test Method** ASTM D-695	15,000 psi	16,000 psi
MAXIMUM OPERATING TEMPERATURE	250°F	225°F
LAP SHEER STRENGTH: **Test Method:** ASTM D-1002	2,000 psi	2,600 psi
GEL TIME AT ROOM TEMPERATURE:	92 minutes	50 minutes
WORKING TIME AT 70°F:	30 minutes	25 minutes

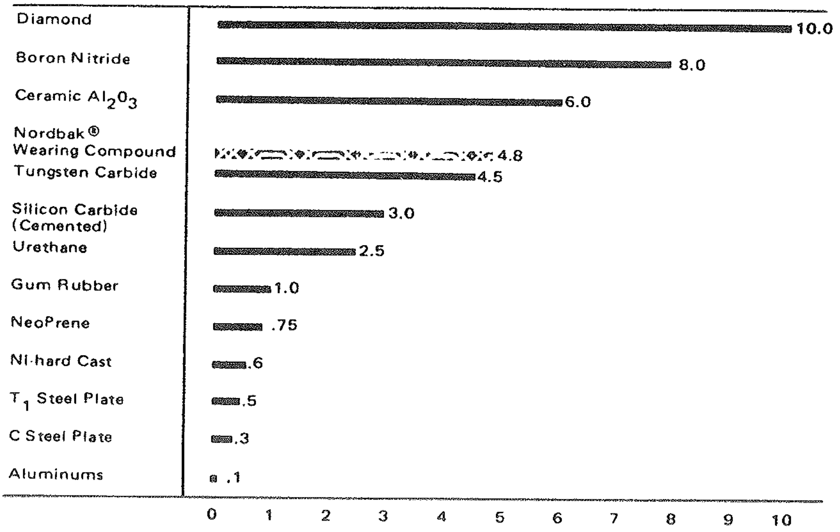
VOLUME OF MATERIAL:

Wearing Compound: 2 Gallon Kit will cover 9-1/2 square feet (.88 square meters) with a 1/4 inch (6mm) thickness or 19 square feet (1.7 square meters) with a 1/8 inch (3mm) thickness.

Steel Trowel Mix: 28 pound Kit will cover 7-3/4 square feet (.7 square meters) with a 1/4 inch (6mm) thickness.

RELATIVE WEAR RESISTANCE OF NORDBAK WEARING COMPOUND VS. OTHER WEAR MATERIALS

(Sliding Fine Grain Abrasion)



FIXMASTER FAST-SET GROUT

Fixmaster fast-set grout is a unique 100% solids epoxy grouting system that reduces maintenance costs sharply. It mixes quickly, and can be applied by just two men, without mixers, wheelbarrows or special equipment.

Ideal for grouting new machinery or replacing old grout which has chipped or broken out. Fixmaster fast-set grout is self-leveling because it is low in viscosity. It sets up stronger than concrete, resists moisture and chemicals, will not shrink, and adheres more securely than ordinary grouts. Fixmaster fast-set grout is ideal for applications where only 1/4" to 1" of material is required. The reliability of Fixmaster fast-set grout has been proven in actual use on countless installations of Nordberg crushers, grinding mills, mine hoists, diesel engines and hydraulic presses, as well as other types of special machinery in service.

FIXMASTER DEEP POUR GROUT

Fixmaster Deep Pour Grout is a 100% solids epoxy grout that offers unique advantages in its combination of strength and economy. It incorporates graded aggregate filler that greatly extends the volume of the mixed grout, with no significant loss of strength.

Fixmaster Deep Pour Grout is designed for pours as deep as 6". Because of its semi-fluid consistency, it flows well under rails and sole plates, and is self-leveling. It firmly maintains critical alignments, withstands high torque loading and vibration, bonds securely to steel and concrete, and is unaffected by operating temperatures up to 180°F. It sets up quickly; machinery is ready for use in 24 hours at 70°F.

For convenience, all components are packaged in one container, which also serves as a mixing vessel. Mixing and application is a simple two-man job that requires no costly mixers or vibrators. Time-consuming cleanup is virtually eliminated.

Typical Uses Include:

- Diesel or Gas Engines
- Compressors
- Generators
- Blowers
- Air Conditioner Units
- Outboard Bearings
- Punch Presses
- Jolt Machines
- Gear Cutting Machines
- Engine Test Stands
- Pulverizers
- Hammermills
- Large Pumps
- Bridge Seals, Rail Approaches, Structural Columns

FIXMASTER HIGH TEMPERATURE GROUT

Fixmaster High Temperature Grout is a 100% solid epoxy grout system formulated to withstand temperature of up to 250°F. This unique grout is stronger than concrete and will adhere where other grouts fail.

Fixmaster High Temperature Grout offers the following superior characteristics:

- Fast Setting
- Superior Strength
- Resists Corrosion
- Withstands High Vibration
- Bonds Securely to Clean Steel and Concrete
- Reduces Replacement Costs
- Withstands High Torque Loading
- Easy to Use
- Insignificant Shrinkage
- Maintains Critical Alignment
- Self-Leveling
- Minimal Downtime Required
- Fills Small Voids
- Withstands High Temperature
- Excellent Impact Strength

Typical Applications

- Diesel Engines
- Compressors
- Generators
- Textile Equipment
- High Temp. Pumps
- Gas Turbines
- Steam Turbines
- Ovens
- Building Columns
- Gantry Rails
- Block Bearings
- Shipyard Equipment
- Crane Rails
- Blowers
- Paper Dryer Sections
- Steel Machinery

TYPICAL PROPERTIES OF FIXMASTER GROUTS

COMPRESSIVE STRENGTH:	Fast Grout	16,5000 psi
Test Method	Deep Pour	15,000 psi
ASTM D-695	High Temperature	18,000 psi
TENSILE STRENGTH:	Fast Grout	4,100 psi
Test Method	Deep Pour	2,500 psi
ASTM D-638	High Temperature	5,500 psi
SHRINKAGE:	Fast Grout	0.0022/Inch
Test Method	Deep Pour	Not Available
ASTM D-2566	High Temperature	0.0022/Inch
GEL TIME:	Fast Grout	20 minutes at 77°F
Test Method	Deep Pour	1 hour at 77°F
Modified SPI-ERF B-70	High Temperature	1 hour at 77°F
POURING VISCOSITY:	Fast Grout	13,000 cps at 77°F
Test Method	Deep Pour	20,000 cps at 77°F
Brookfield Viscometer	High Temperature	15,000 cps at 77°F
MAXIMUM OPERATING TEMPERATURE:	Fast Grout	200°F
	Deep Pour	225°F
	High Temperature	250°F
WORKING TIME AT 70 °F:	Fast Grout	15 minutes
	Deep Pour	30 minutes
	High Temperature	15 minutes

VOLUME OF MATERIAL:

Fast Set 2 Gallon (7.5 Liters) Kit contains 340 cubic inches (1/5 cubic foot) of material.

Deep Pour 5 Gallon (18.9 Liters) Kit contains 730 cubic inches (1/2 cubic foot) of material.

High Temperature 2 Gallon (7.5 Liters) Kit contains 320 cubic inches (1/5 cubic foot) of material.

All data is furnished for your investigation and independent verification. While the information herein is believed to be correct, Nordberg Inc. makes no representation as to its accuracy. Nordberg Inc. shall in no event be responsible for any damages directly or indirectly resulting from publication or use of or reliance upon data contained herein. Nordberg Inc. makes no warranty, either expressed or implied, of merchantability or fitness or of any nature with respect to the products or the data herein.

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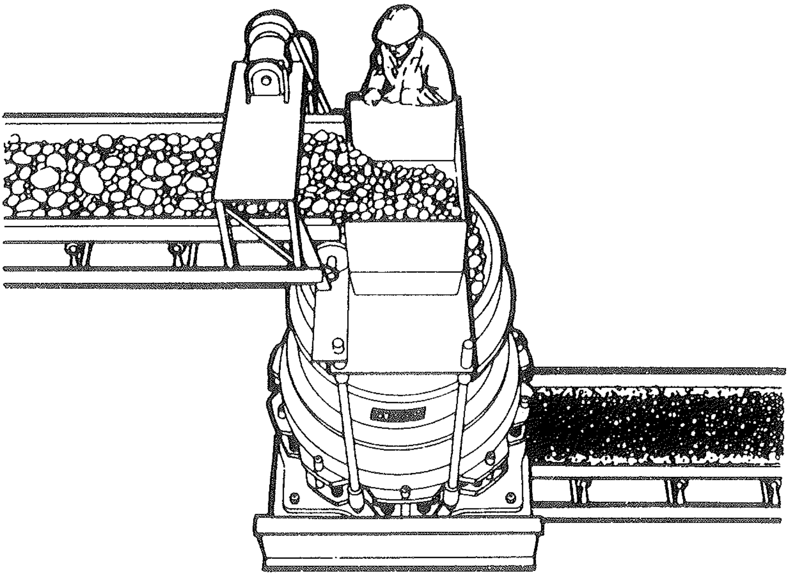
Mineral Research and Test Center



NORDBERG
MINERAL RESEARCH AND TEST CENTER

The Nordberg Mineral Research and Test Center has the personnel and equipment to conduct pilot tests to determine the crushing and grinding characteristics of any ore or mineral. The tests help provide data on capacity, production distribution, and amount of power required to crush a specific ore or rock. These tests provide valuable information for selection the right size crusher for new or existing installations.

The Test Center can set up a systems approach to your problem. Rocks, ores and minerals can be reduced with various crushers and mills, and separated and sized with the latest in screen technology. Capacities can be closely estimated to tell you what to expect in actual field operation.

A major aim of the Center is to discover the most efficient, economical methods of processing your rock or ore, to help improve your profits. We can provide a flow sheet for every stage in your plant, We can replace guesswork with knowledge, based on observed facts. We can match reduction machinery precisely to your material, to guide you in equipment selection and plant expansion. We can pilot-test crushing, screening or grinding...in ball mills. And we can run accurate laboratory tests for crushability, grindability and other characteristics.

Most tests can be completed within a week. Screen analyses are usually handled in one day. And while the results may differ slightly from actual production because of sample variations, the Test Center's track record over the years has been excellent.

Your test results are held in complete confidence, and become your property. If you wish, you're invited to participate in planning and observing your tests.

FACILITIES: PILOT PLANT AND LAB

Pilot Plant Equipment

HP200 Cone Crusher
WF200 WaterFlush Cone Crusher
36" Gyradisc Crusher
5' x 12' D.D. G.P. Screen
0604 Horizontal Shaft Impact Crusher
2' Diameter Ball Mill
12" x 36" Jaw Crusher

Bench Scale Equipment

5" x 6" Jaw Crusher
2" x 3" Jaw Crusher
10" Cone Crusher
2' x 3' Uniflex Screen
1' x 1' Uniflex Screen
V.S.I. Impactor
Screen Analyses Equipment (Wet/Dry)
Paddle Abrasion Tester
Impact Pendulum Tester
1' Square Ball Mill
1' Diameter Rod Mill
Laboratory Pulverizer

TESTING AVAILABLE

Tests Conducted (in house)

Ball Mill Grindability
Rod Mill Grindability
Screen Analysis
Bench Scale Crusher
Flakiness
Impact Crushability
Paddle Abrasion
Particle Shape (Voids)
Cone Crusher Pilot
Gyradisc Pilot
Ball Mill Pilot
W.F. Crusher Pilot

Tests Conducted (out of house)

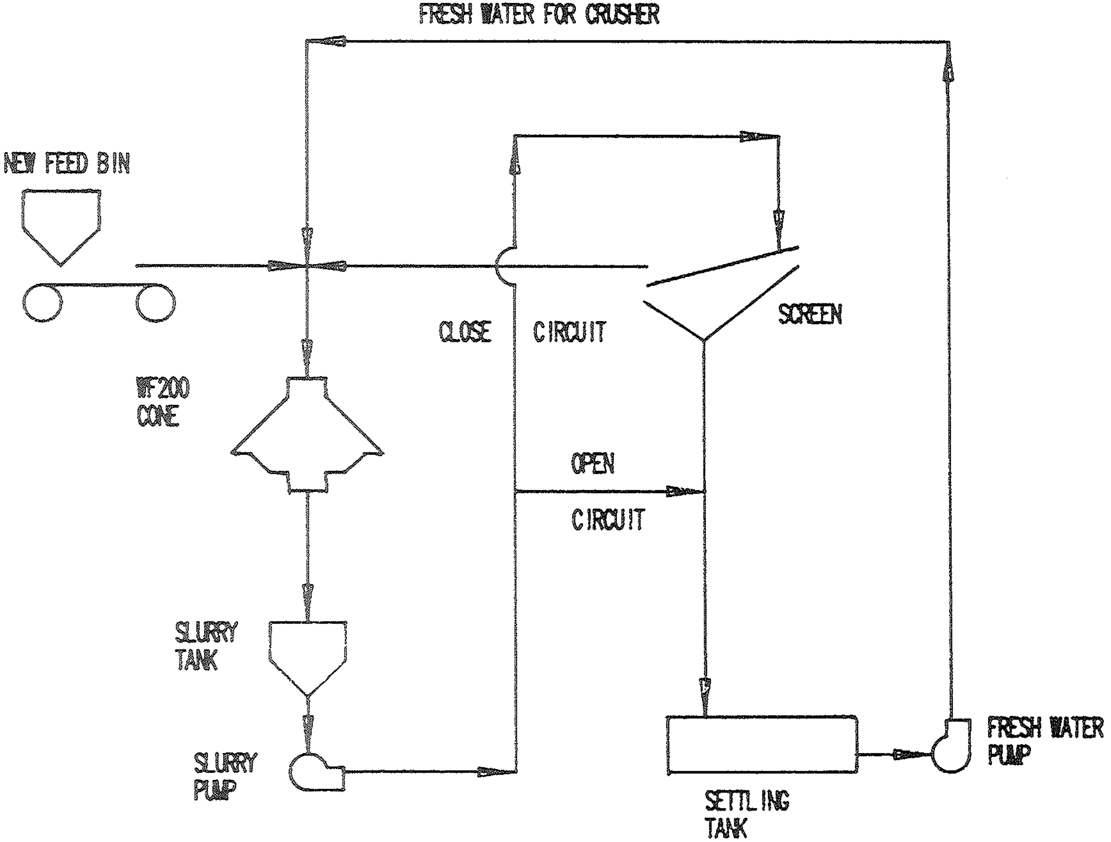
Compressive Strength
Chemical Analysis
Soundness
L.A. Raddler

MATERIALS WE HAVE TESTED

Limestones
Copper Ores
Gravels
Uranium Ores
Iron Ores
Cement
Slags
Steel Mill Scale
Basalts
Sands
Lead and Zinc Ores
Seeds
Granites
Oil Shales
Trap Rocks
Gold Ores
Ferrosilicon
Quartzites
Coal
Lignites
Shales
Talcs
Deep Sea Nodules
Gypsum
Molybdenum Ores
Clinkers
Ferromanganese
Sandstones
Taconites
Shells
Laterites
Cokes
Chars
Nickel Ores
Porphyry
Aplite
Monzonites
Varites
Potash
Bernites
Bricks
Andesites
Ceramics
Clays
Phosphate Rocks

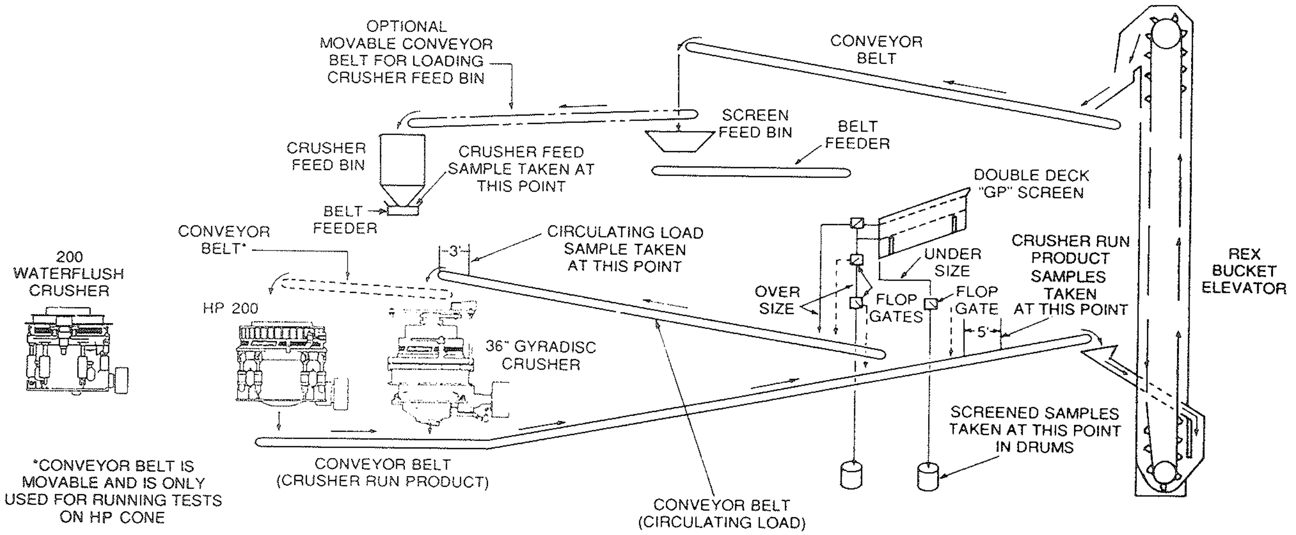
MINERAL RESEARCH AND TEST CENTER

FLOW SHEET OF WATERFLUSH™ CIRCUIT



MINERAL RESEARCH AND TEST CENTER

FLOE SHEET OF SECONDARY CRUSHING AND SCREENING SECTION



*One of three circuits in operation at the Test Center. The other two are a horizontal shaft impactor and a jaw circuit.

IMPACT CRUSHABILITY TEST

1. Ten to fifteen samples of approximately 3" x 2" dimensions with two natural parallel or near parallel side of 2 to 3 inch widths are selected.

2. Each sample piece is placed on a pedestal and struck simultaneously by two opposing hammers of standard size and shape.

3. The height of the hammers are increased until the sample is broken and the total foot-pounds (A) of force are recorded. The width (W) of the sample at the fracture is recorded.

4. The Work Index is calculated from the equation:

$$\frac{2.59\left(\frac{A}{W}\right)}{Sp.Gr.}$$

5. Two W.I.'s are recorded: The maximum W.I. and the average W.I. of the samples tested.

IMPACT W.I.

	Maximum	Average
Very Hard		
Trap Rock	38.79	29.75
Gabbro Rock	41.21	24.68
Trap Rock	37.84	30.99
Quartzite	24.51	19.81
Granite (Fine Grain)	28.44	20.76
Hard		
Lead-Zinc	21.14	13.37
Limestone	22.27	15.82
Granite	18.10	13.68
Granite	22.06	16.76
Marble	19.71	13.47
Medium		
Copper Ore	12.23	8.01
Andesite	14.19	9.12
Granite (Large Grain)	19.38	10.33
Copper Ore	18.77	10.15
Marble	18.65	9.40
Magnetite	18.13	9.38
Soft		
Limestone	9.00	4.87
Iron Ore	8.30	4.73
Shale	8.44	6.07
Bauxite	15.62	6.22
Bauxite Clay	10.49	5.79

Nordberg®

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Aggregate and Mineral Information

AGGREGATE AND MINERAL TERMS DEFINED

Abrasives - A substance for abrading, as for grinding, polishing, etc. Practically every nonmetallic mineral is highly abrasive. A great variety of silica and silicate materials are mixed commercially for their abrasive value in their natural state.

Aggregate - The mineral material, such as sand, gravel, shells, slag, or broken stone, or combinations thereof, with which cement or bituminous material is mixed to form a mortar or concrete. "Fine Aggregate" may be considered as the material that will pass a 1/4-inch screen. "Coarse Aggregate" is the material that will not pass a 1/4-inch screen.

Agricultural Limestone - Ground and pulverized forms of limestone used for direct application to the soil.

Aluminus Silicates - Several nonmetallics in this group are sometimes mined domestically - and alusite, sillimanite, kyanite, dumortierite, mullite, topaz, etc. Usually associated in nature with other minerals, they convert to mullite for refractory purposes.

Amber - Many types of plants, particularly fir trees and pine trees, give off a sticky substance called resin, which soon dries and hardens. Hard, fossil resin from ancient trees is known as amber and is composed of carbon, oxygen, hydrogen and a trace of sulfur, Amber, because of its organic origin, is not a true mineral.

Amber, in the state of Kansas, is called jellinite. It is yellow to brownish in color, is clouded or translucent and has a resinous to waxy luster. Many specimens show a banded structure and can be scratched by a copper penney but not by the fingernail. It is brittle, breaks with a shell-like (conchoidal) fracture and is very light in weight - only slightly heavier than water. It burns readily, giving a smoky flame. Amber in Kansas has been found in lignite beds of cretaceous age, where it occurs as rounded and irregular masses from the size of a pea to four inches in diameter.

Amphibolite - A rock consisting chiefly of hornblende, or of some member of the amphibole group. It is , as a rule, a synonym of hornblends schist, but is preferable to the latter, when the schistosity is not marked (Kemp).

Amplitude - Distance or stroke travelled by the screen between its highest and its lowest positions.

Andesite - A volcanic rock of porhyritic or felsitic texture, whose crystallized minerals are plagioclastic and one or more of the following: biotite, hornblends, and augite, (Kemp).

Anhydrite - Anhydrite, which is composed of calcium sulfate ($CaSo_4$), is one of the three main evaporite deposits, the other two being gypsum and halite. It occurs commonly as gray, crystalline masses, although some anhydrite has a fibrous structure. It may occur as individual crystals in other rocks; particularly in dolomite. It has a gloomy luster, is translucent and is harder and heavier than gypsum, for although it can be scratched easily with a knife, it cannot be scratched with the fingernail. Anhydrite may change to gypsum if water is added as for example; at surface exposures, fine-grained dolomite and anhydrite look similar but can be distinguished from one another in that hydrochloric acid will not act on anhydrite.

Some anhydrites are found in deposits of Permian Age associated with the beds of

gypsum, dolomite, and red silt. It is also found in the ceilings of some gypsum caves.

Aragonite — Aragonite has the same chemical composition as calcite (CaCo3), but it differs from calcite in having poorer cleavage and in having a different crystal form. Its crystals commonly occur as radiating groups of fibrous or needle-like shapes; like calcite, aragonite fizzes and dissolves readily in dilute hydrochloric acid and can be scratched with a knife but not with a copper coin. This mineral, which is colorless to white, gray, yellow, green, brown, and violet, is ordinarily found as a vein mineral in cave deposits, and as the pearly layer of many types of shells.

Aragonite is much less common than calcite because it changes easily to calcite without altering its external shape. It is difficult to identify in the field. The mineral has been reported in several places, as nodules in a clay deposit, and in a sand pit, as small bugs in a quarry and in many septarian concretions in the cretaceous shales of Western Kansas.

Artificial Sands — Commonly called crusher screenings, they are the fine materials produced when gravel or stone is crushed. These screenings vary considerably as to angularity and gradation, depending upon the type of rock crushed, but fairly wellgraded sands can be produced in this way. Most crusher screenings range in gradation from 1/4-inch down to and including 0 to 6% passing the 200 mesh sieve, although in most cases they are deficient in the No. 40 to No. 80 mesh size.

Asbestos — (Mineral) — A grayish or greenish variety of amphibole, occurring in long, delicate fibers or in fibrous masses. It is noncombustible, nonconducting, and chemically resistant.

Asphalt Rock — Asphalt is a solid or nearly solid organic substance composed of carbon and hydrogen, which is formed when the lighter parts of petroleum evaporate and the heavy tarry residue remains behind. Natural asphalt, that is made by nature and not in an oil refinery, is found in the pores of some limestone and sandstone. It occurs in rocks of the Pennsylvanian Age and in small amounts in cretaceous sandstone. Since many porous sandstones and limestones do not have asphalt in them, particularly where the rocks outcrop and weathering has a chance to act on them, much exploration must be done in order to find a good deposit of asphalt rock. This is usually done by digging small pits or quarries, or by drilling shallow test holes.

Backbreak — Undesirable blasting effect where ground is broken behind the line of blastholes.

Bank Gravel — Gravel found in natural deposits, usually more or less intermixed with fine material, such as sand or clay, or combinations thereof, gravelly clay, gravelly sand, clayey gravel and sandy gravel, indicate the varying proportions of the materials in the mixture.

Bank Sands — Sand pits containing sand with little or no gravel. This sand contains from 0 to 12% clay and silt and has a gradation suitable for sand asphalt, a bituminous mix.

Barite — Barite (barium sulfate, BaSO4) is a common mineral, but it is not found as a rule in large quantities because of its high density. It is sometimes called "heavy spar." It occurs as flat tabular crystals, either singly or in groups, and it also occurs in granular or earthy forms. The individual crystals are transparent to opaque and have a glassy luster and perfect cleavage in two directions.

Barite is usually colorless or white, but may be light shades of blue, yellow, or red. It can be scratched with a knife, but

not with the fingernail. In appearance, it resembles gypsum, calcite, or celestite. However, aside from its relatively heavy weight, it can be distinguished from gypsum by its greater hardness and from calcite because it does not fizz in hydrochloric acid. A flame test is the best means of distinguishing between barite and celestite. If powdered barite is heated on a clean platinum wire in a Bunsen burner, the flame will become green, but celestite will turn the flame bright red.

Barite is used in paint pigments, as a filler in paper and cloth, in making glazes for pottery, and in the refining of sugar.

Basalt — A word of ancient but uncertain etymology. It is employed as a rock name in its restricted sense for porphyritic and felsitic rocks consisting of augite, olivine, and plagioclase with varying amounts of glassy base which may entirely disappear. In a broader sense the basalt or basaltic group is used to include all the dark basic volcanic rocks, such as the true basalts; the nepheline-, leucite-, and melilite-basalts; the augites and limburgites; the diabases, and melaphyres.

Base Course — The first or lowest course of a road, as of a foundation. Also called Foundation course.

Bauxite — (Mineral) — A ferruginous aluminum hydroxide, essentially $Al_2O_32H_2O$, but consisting of several minerals occurring in oolitic masses and in earthy form. It is a nonmetallic clay mineral and has several industrial applications.

Bench — Mining terrace.

Beneficiation — Upgrading ores by breaking them into particles and removing the waste.

Bentonite — Bentonite is a clay formed by chemical alteration of volcanic ash. It is particularly interesting because of its properties of swelling when water is added. It may swell to as much as 15 times its original bulk, and it forms a milky cloud in the water. Some bentonites can be identified by their waxy or soapy appearance. Some thin deposits are interbedded with chalk and chalky shale.

Blinding — Reduction of the effective area of a screen opening, caused by moist fines building up on the inner surface of the wire until the opening is wholly or partially closed.

Blockholding — Breaking of big rocks by drilling them for dynamite.

Blow Sands — This sand is used chiefly as a blend to fill in the gradation between No. 40 and No. 100 mesh that may be deficient in other sands.

Borax and Boron — The extremely versatile chemical boron is found in many minerals, of which borax, kernite and colemanite are currently most important. Boron is a nonmetallic element occurring only in combination, as in borax. (Borax — a crystalline, slightly alkaline borate of sodium. $Na_2B_4O_7$, used as a flux, cleansing agent, antiseptic, etc.) Boron is used in glass-making, ceramics, metallurgy, soil fertilization, cosmetics, detergents, antiseptics, atomic energy and hundreds of other industries.

Boulder or Bowlder — A fragment of rock brought by natural means from a distance (through this notion of transportation from a distance is not always in later usage, involved) and usually large and rounded in shape. Cobble stones taken from riverbeds are, in some American localities. called bowlders.

Boulder Clay — Boulder clay is an extremely varied deposit consisting, as

the name suggests, of particles of all sizes, from large boulders to clay. It is a typical product of glacial action and is often called glacial till. Boulder clay forms low, rounded, rolling hills covered with loess, soil and vegetation. The boulders and pebbles, which have been carried by ice from both local and distant rocks, are of many different types. They include limestone, sandstone, quartzite, granite, basalt, and many others. Most of them have been deeply weathered since they were left by the melting of the ice sheet; they have been weathered so much that a hard granite can be crumbled with bare hands. Upon close examination, some of the pebbles and boulders are seen to be scratched and polished from rubbing against other rocks in the ice.

Breccia — A fragmental rock whose components are angular and therefore, as distinguished from conglomerates, are not waterworn. There are friction or fault breccias, talusbreccias and eruptive breccias. (Kemp)

Bromine — An element, normally a deepred caustic liquid emitting an irritating, reddish-brown ill-smelling vapor. Responsible for "knock-free" gasoline, bromine is also used in medicine, photographic agents, dyes, chemicals, soil fumigation, etc.

Burden — Rock between the open bank and the line of blastholes.

Calcite — Calcite (calcium carbonate, $CaCO_3$), is the important mineral in limestone and is therefore, one of the most common minerals, and contains 56 percent lime, CaO. Generally it is white or colorless but it may be tinted gray, red, green, or blue. It occurs in many varieties of crystal forms (more than 300 have been described). Calcite can be scratched by a knife, but not by the fingernail, and it fizzes freely in cold hydrochloric acid. If a large crystal of calcite is shattered with a hammer, is breaks into smaller rhombshaped blocks because it has perfect cleavage in three directions.

Besides being the important mineral in limestone, calcite occurs as a common cementing material in some sandstones. It is found in many calcareous shales and clays and as veins in some igneous rocks in the cretaceous niobra chalk and other cretaceous rocks, it is found in rather large veins. Calcite is an important part of many concretions; brown calcite and colorless to yellow calcite crystals are common in some septarian concretions of shale. Tiny calcite crystals form the lining of geodes in certain permian limestones and shales and they coat the insides of many fossil shells. Good calcite crystals are found in some lead and zinc mines, most of these are pale yellow and some are quite large.

Caliche — 1. (Mex.) Feldspar; a white clay. 2. (Mex and Southwest U.S.) Gravel, sand or desert debris cemented by porous calcium carbonate; also the calcium carbonate itself.

Calcium Chloride — A crystalline compound, $CaCl_2$, used in its anhydrous state as a white porous solid as a drying agent, to lay dust. It is also used for highway ice and dust control.

Casing — Pipe placed in drill hole to keep it from caving.

Celestite — Celestite (strontium sulfate, $SrSO_4$) is similar to barite in appearance, in geologic occurrence and in crystal form. It has a glassy luster and its crystals are colorless, white, or a faint blue or red. This mineral is also found as radiating pink fibers, as vein fillings, and as scattered particles. Celestite cannot be scratched by the fingernail, but can be scratched by a penny. It differs from barite in its lighter weight and in its property of coloring a flame red.

Celestite has been found in solid blue

crystals and as pink to white radiating fibers. It also has been found as pink crystals and as veins and has been found at the top of Permian Rocks below cretaceous sands and shales.

Cerussite — Cerussite (lead carbonate, $PbCO_3$) occurs as granular masses and as platy crystals which commonly cross each other to form a lattice-like effect. Cerussite has a brilliant, glassy luster, is colorless or white and can be scratched by a penny but not by the fingernail. It fizzes in cold hydrochloric acid and is very heavy for a nonmetallic mineral.

Small amounts of cerussite are occasionally found as a result of the chemical change of galena (lead sulfide) in the near surface parts of lead deposits.

Chalcopyrite — An important ore of copper where it occurs in abundance, chalcopyrite or copper pyrite is a sulfide of copper and iron $CuFeS_2$). It is a brassy yellow mineral that makes a greenish black streak and has a bright metallic luster. It is brittle, may be tarnished, can be scratched by a knife but not by a penny. It occurs normally as four sided pyramid-like crystals but the crystals are usually poorly formed when the mineral occurs as massive sulfide ore. Chalcopyrite is very similar in appearance to pyrite, but is softer than pyrite (pyrite cannot be scratched by a knife) and it has a greenish sheen which pyrite does not have.

Chalcopyrite is sometimes found with dolomite crystals and with lead and zinc ores and is sometimes associated with barite.

Chamber — Enlarged portion of a blasthold made by blasting. Purpose is to make room for larger dynamite charge for main blast.

Chats — (Northumb) Small pieces of stone with ore. (Eng.) A low grade of lead ore. Also middlings which are to be crushed and subjected to further treatment. The mineral and rocks mixed together which must be crushed and cleaned before sold as mineral. Chats are not the same as tailings, as the latter are not thrown aside to keep for future milling.

Chert — A compact, siliceous rock formed of chalcedonic or opaline silica, one or both, and of organic or precipitated origin. Chert occurs distributed through limestone, affording cherty limestones. Flint is a variety of chert. Chert is especially common in the Carboniferous rocks of southwest Missouri. Also see Hornstone.

Chips — 100 percent fractured stone usually passing 1/2-inch square mesh sieve but retained on No. 8 sieve. Applied over seal coats, broomed and rolled to provide a skidproof surface and to prevent bleeding on bituminous roads.

Churn Drill — Drill head is lifted by rope and dropped successively to make hole (old fashioned).

Claritier — Large tanks used for cleaning water or solutions of foreign matter by settling. A device in which particles of mixed size and weight are sorted by settling through a fluid.

Clay — An earth material of extremely fine texture, smaller than .005 millimeters in particle size, and is plastic and swells when wet. Pure clay is not a good stabilizing agent because of its plasticity index.

Closed Circuit System — A series of conveyors and/or elevating devices which return oversize material back to a crusher for further reduction.

COAL

Lignite — Lignite ranges in appearance

from a light brown to a dark brown, compact, dull, earthy mass to a bright, black, banded mass, and it yields a brown powder when ground or when rubbed over a rough white surface. As American lignite comes from the mine it contains 30 to 40 percent moisture. When exposed to the air it soon slacks or falls to pieces because of loss of moisture. If it is not stored properly, it will take fire spontaneously. Although there are thousands of square miles of lignite deposits in the United States, production of this rank of coal is not yet important nationally. It is difficult to store and its heating value is low making it uneconomical to ship very far. However, lignite can be dried, briquetted or made into gas suitable for the reduction of iron ore, the production of synthetic liquid fuels and other uses.

Bituminous Coal — Bituminous coal is the most abundant and widespread rank of coal in the United States. It is the coal used most commonly for industrial, power, railroad and heating purposes. Bituminous coal may be either coking or non-coking. This property is not based on the rank of the coal, but rather on whether it will produce a coke when processed in a coke oven. Nearly all eastern bituminous coals have coking properties, but many of the western bituminous coals are non-coking or free burning.

A coking, or, as it is sometimes called, caking coal, is one that softens and runs together when it becomes almost hot enough to take fire. As it is heated further, some degradation of coal substance occurs, and the volatile matter escapes as a gas. When the coal is heated red hot in a sealed oven where there is little or no air, a dull gray porous mass called coke remains after the volatile liquids and gases have been driven off. Because coke consists largely of fixed carbon, the coking process is often called "carbonization". Coke and the gases liberated have many important uses.

Most bituminous coals appear black and lustrous in the pile; but, if you look at them closely you will observe a banded structure with alternate layers of bright, glossy coal and of dull grayish-black coal. In some coals, this dull material predominates and these coals have a dull grayish-black appearance.

Anthracite — Anthracite, sometimes called hard coal, has a brilliant luster and a uniform texture. If you handle anthracite, it will not soil your fingers as does coal of lower ranks. Anthracite has a higher percentage of fixed carbon and a lower percentage of volatile matter than the lower rank coals. It burns slowly with a pale blue flame free from smoke. Most anthracite has a somewhat lower heating value than the highest grade bituminous coals, but its lack of soot and the fact that it will burn longer without attention make anthracite an ideal domestic fuel.

Common Banded Coal — Common banded coal, sometimes called bright coal, is the variety that includes most coals. It is composed of both anthraxylon and attritus in varying proportion and has a bright luster.

Splint Coals — Splint coals are composed almost wholly of attritus, with only a little anthraxylon. The coal is a dull grayish-black and is hard and tough. When mined, it breaks into block lumps; because of this characteristic, it is called "block coal" in some mining regions. Splint coal is good for steam power plants. When heated, it is inclined to splinter and makes a better coke when used in blends with banded coal.

Sub-Bituminous Coal — Sub-bituminous coal is black; and as it is mined, it looks a great deal like the bituminous coal seen in coal yards. It contains from 15 to 30 percent moisture. The range of heating

value of sub-bituminous "A" coal is the same as that of high-volatile "C" bituminous coal. Sub-bituminous coal is entirely non-coking. Like lignite, it weathers or slacks rapidly upon exposure to air and is subject to spontaneous combustion if not stored properly. Because of the same disadvantageous features as lignite, it is used principally in the areas where it is mined.

Cannel Coal — Cannel coals are made up entirely of attritus, often rich in spores. Spores are the reproductive organs of the lower plants that do not produce seeds. Cannel coals are often rich in volatile matter and burn with a long yellow flame. They used to be called "candle" coals because of the appearance of the flame and because many of them can be lighted with a match or a piece of burning paper. It usually occurs in small lenses or deposits in beds of other coals and must be separated from the other coal during mining. In the original coal swamps, the spore and seed case of plants and finely divided particles of woody material floated upon the open water until they became waterlogged, sank to the bottom and finally changed in to cannel coal.

Boghead Coal — Boghead coal is a variety of bituminous or sub-bituminous coal that looks and burns much like cannel coal. It is made up largely of the remains of algae water plants that form the greenish or brownish scum you often see on fresh water ponds and reservoirs in summer and fall. It is rich in volatile hydrocarbons that produce illuminating gas. When distilled, it yields a great deal of tar and oil. Like cannel coal, it is usually found in small deposits or lenses.

Coarse Screening — Materials above 4".

Compaction — Soil compaction may be defined as the process of increasing the density of a soil by (1) expelling air from the pores, (2) decreasing thickness of water films thereby increasing cohesion, and (3) increasing mechanical bond, or interlocking, of soil particles. This is accomplished by vibratory rolling, static rolling, static loading, and tamping.

Compaction Test Procedure — The general procedure is to specify the size, weight, height of drop and number of blows to be delivered by a tamper to a confined sample, and then to measure the resulting density both wet and dry. The process is repeated, varying the water content, until the highest density is recorded for the method. The moisture content of the wet sample corresponding to the highest density of the dry sample is the optimum. Some special variations in method may exist but the most common prescribed is the AASHO Modified.

Coral — The solid secretion of coral polyps, composed almost wholly of calcium carbonate, which forms reefs and tree-like and globular masses.

Conglomerate — Anaggregate of rounded and waterworn pebbles and boulders cemented together into a coherent rock. Deposited by streams or waves, generally with some sorting and stratification. Compare Breccia.

Conglomerate is a hardened, generally cemented gravel, and like sand, silt and clay, has been formed by the breaking down of older rocks and by later redisposition.

Commonly it is found interbedded with layers of sandstone. It also occurs at the base of many Pennsylvanian formations.

Conglomerate and gravel are used in making concrete, in surfacing roads and as railroad ballast.

Conveyors — A device consisting of a steel frame equipped with rollers and pulleys over which a continuous rubber belt travels and used for delivery of material from one portion of a plant to

another. Note: Conveyors are further described by a word describing their use; i.e., a "feed" conveyor usually feeds material into a plant, crusher or on to a screen. A "delivery" conveyor usually delivers material from any of the components to another component, or to a truck or stockpile.

Coverage — One complete application of compactive effort over the entire area being compacted. Three passes, or one and one half round trips, with a Cedarapids Compactor results in one coverage on a strip twelve feet in width.

Deflection — The amount of downward vertical movement of a surface due to the application of a load to the surface.

Density — Soil density is based on dry weight per cubic foot. Field densities obtained by compaction are expressed as a percent of the standard. Proctor, Mod. Proctor, or Mod. A.A.S.H.O. laboratory compaction results. These percentages may be greater than 100 when modern equipment is used.

Detonator — Fuse for setting off dynamite, percussion cap.

Diabase — A basic igneous rock usually occurring in dikes or intrusive sheets, and composed essentially of plagioclase feldspar and augite with small quantities of magnetite and apatite. The plagioclase forms lathshaped crystals lying in all directions among the dark irregular augite grains, giving rise to the peculiar diabasic or ophitic texture, which is a distinctive feature in the coarser-grained occurrence (U.S. Geol. Surv.). Diabase is often used as a prefix for double names, as diabase-aphanite, diabase-gabbro, etc. (Kemp).

Diorite — A granitoid rock composed essentially of hornblende and feldspar which is mostly or wholly plagioclase, with accessory biotite and (or) augite. Minute grains of magnetic and titanite may be visible. Ouartz may be present in considerable amount, in which case the rock is called quartz diorite. Ouartz diorites grade into tonalities and granodiorites. (U S. Geol. Surv.).

Dolomite — Dolomites are fine to coarse grained rocks which in the pure state are light colored. On weathering they tend to become buff or tan because of impurities which consist commonly of small amounts of pyrite, siderite, or marcasite or of iron in the dolomite crystals. Dolomites may be formed much as limestones are formed: for example, by chemical precipitation, or by the action of waves and streams on older dolomites. They are also converted from limestone by a process appropriately called dolomitization. This involves the replacement of calcium by magnesium or the solution and removal of the calcium carbonate. The change may take place before or after the rock has been solidified, and is caused by the action of sea water, ground water, or hot mineral water.

Dolomite is used in most of the ways that limestone may be employed and in addition, it is a possible source of magnesium.

The mineral dolomite is composed of calcium magnesium carbonate ($CaMg(CO_3)_2$) and is closely related to calcite. In large masses the mineral forms the rock called dolomite. It may be white, gray, greenish-gray, brown, or pink, and has a glassy to pearly luster. It occurs in coarse to fine grained granular, masses and in crystals. Most dolomite crystals are rhomb-shaped like calcite cleavage blocks, but unlike most other minerals, the crystal faces are typically curved. Dolomite is slightly harder than calcite, although it can be easily scratched by a knife. It will not fizz in cold hydrochloric acid unless first ground to a powder or the acid heated.

Down-The-Hole-Driff (DHD) — A drill in which mechanism enters and follows down drill hole as it is developed.

Dragline — A long-boomed excavator with a bucket filled by dropping and dragging by rope towards the machine.

Epsomite — Epsom salts are recovered from lake bed deposits or by chemical treatment of rocks such as dolomite or talc that contain magnesite. Washington is the major producer, having several lake deposits. Medicinals use the purified chemical grade, while the technical grade goes into fertilizers, enamels, paints and soaps.

Evaporates — Rocks formed by the evaporation of water are known as evaporates. This evaporation may take place either in shallow basins on the land or in the sea. However, the rocks which were laid down under the sea form the thicker and more widespread deposits. Rocks formed in this way include deposits of gypsum, anhydrite, and common salt or halite.

Sea water contains many salts in solution. These are brought into the ocean by rivers which are continually wearing down or eroding the land surfaces, and dissolving the salts. When the sea water evaporates, the salts settle to the bottom. The less soluble — those that dissolve less readily in water — are deposited first during the evaporation process. Calcium sulphate, the compound that forms gypsum and anhydrite, is among the least soluble and consequently is one of the first deposited after dolomite. Next in order of solubility and hence deposition is sodium chloride or common table salt.

Evaporite deposits are described more fully under the separate mineral names gypsum, anhydrite and halite.

The evaporates formed on the land are neither so thick nor so common as those formed under the sea.

Feeder — There are several type of feeders, one type is a device placed under a hopper which conveys material into a plant, the two types most commonly used are the Vibrating Grizzly Feeder and continuous steel Apron type (you may also find a reciprocating plate feeder (back and forth motion). Another type is a device placed under a hopper/bin/surge pile which conveys material into a crusher, onto a conveyor, into a truck, etc. at a uniform rate. This type is commanly refereed to as a Electromagnetic Vibrating Feeder.

Feldspar — A general name for a group of abundant rock-forming minerals, the names and compositions of which are as follows: Orthoclase, Microcline, Anorthoclase, Plagioclase, Oligoclase, Andesine, Labradorite, Bytownite, Celsian, and HvaloPhane. The name of the mineral is often prehxed to the names of those rocks that contain it such as feldspar-porphyry, feldspar-basalt, etc. The term feldspar applies not merely to one but to all members of a group of minerals composed of aluminum silicates carrying principally sodium, calcium, or potassium. The feldspars are light in color (pink, green, white, and gray), have a glassy or satiny luster and have a good cleavage in two directions, almost at right angles to each other. They cannot be scratched by a knife. Most feldspars occur in igneous rocks. Feldspar pebbles may be distinguished from quartz pebbles by the good cleavage.

Filler — Relatively fine material used to fill the voids in aggregate.

Fine Grade Aggregates — Material which will pass a No. 10 mesh screen and retained on No. 200.

Fine Screening — Materials below 3/8".

Finished Product — The resultant material

after it has been processed (crushed, screened, sometimes washed) to the desired size and specifications.

Fire Clay — Clay capable of enduring high heat without fusing, and hence used for firebrick.

Fluorspar: Fluorite — The mineral calcium fluoride, CaF_2. Color commonly purple, green, or white. It is the fourth in the scale of hardness, or next higher than calcite, and may be scratched by a steel point.

Frequency — Number of pulsations per minute produced by the vibrator.

Fullers Earth — A clay-like earthy substance used in fulling cloth, as a filter medium, and as a catalyst.

Gabbro — A finely to coarsely crystalline igneous rock composed mainly of limesoda feldspar (labradorite or anorthite), pyroxene, and frequently olivine. Magnetite or limonite, or both, and apatite are necessary minerals. It is generally dark colored. Gabbros composed largely or wholly of feldspar are called anorthosites, and those containing othrhombic pyroxene are often called norites. (U.S. Geol. Surv.).

Galena — Galena, the principle ore of lead, is composed of lead sulfide (PbS). It is found in dark gray, lead colored, cube shaped crystals which break into cubic, right angled fragments. Some galena crystals are very large. Galena is heavy, has a metallic luster on fresh surfaces, a gray-black streak and is so soft that it will mark on paper.

Garnet — Garnets are a group of minerals whose crystals have many faces all of about equal size. They have a glassy luster and are hard enough to scratch window glass. Most garnet are red to brown, but some are black, green, or colorless. In chemical composition, they are silicates of calcium, magnesium, iron, manganese, aluminum, and chromium in various combinations, the aluminum silicate varieties predominating.

Gneiss — A layered crystalline rock with a more or less well-developed cleavage, but without the fissility of schist. (U.S. Geol. Surv.) The most common varieties are micagneiss, consisting of feldspar, quartz; and mica; and hornblende-gneiss, consisting of feldspar, quartz, and hornblende.

Glosarite — Glosarite ($ZnSO_47H_2O$) is zinc sulphate containing water and is formed by chemical action on sphalerite. It is sometimes found as long, slender, needle like crystals.

Graded Aggregate — A term describing a mineral aggregate in which there is a continuous grading in the sizes of mineral fragments from coarse to fine, the coarser sizes being many times the diameter of the finer sizes.

Granite — A granular igneous rock composed essentially of quartz, orthoclase or microcline, and mica. Commonly a part of the feldspar is plagioclase. The mica may be either biotite or muscovite or both. Hornblende is a common and augite an uncommon component. Apatite, zircon, and magnetite are always present, generally as very small portions. Commercially, almost all compact igneous rocks are called granite as distinguished from slate, sandstone, and marble.

Gravel — Small stones and pebbles or a mixture of sand and small stones; more specifically, fragments of rock worn by the action of air and water, larger and coarser than sand. The term gravel used loosely, usually means a rock composed of particles ranging from sand to pebble size or larger (2mm to 64mm). Gravel deposits vary greatly in mineral

composition size, shape, and color. There are gravels which consist mainly of just one mineral, as chert or flint weathered from the Pennsylvanian and Permian Rocks, or feldspar, agate, clear transparent quartz, native copper, granite, basalt (a fine grained rock) and other igneous rocks.

Gravel Pit Sands — Produced by separating sand (material passing No. 4 sieve) from gravel with a mechanical screen. This type of sand sometimes contains quantities of clay and has a fairly complete gradation ranging from coarse to very fine.

Gravity Separation — Separation of mineral particles by difference in specific gravity; jigs, tables, spirals are common machines.

Greensand — A sedimentary deposit consisting of dark greenish grains of glauconite, often mingled with clay or sand. It is primarily used for water softening and purification. Agricultural use is a new development.

Grit — 1) In petrology, a sandstone composed of coarse, angular grains and very small pebbles. 2) An artificial stone for sharpening tools. Standard grades are coarse, medium and fine. Coarse stones cut very rapidly, but leave a rough edge. Medium stones do not cut as fast as coarse stones but leave a smoother edge. Fine stones are still slower cutting, but are useful where extremely fine edges are desired. 3) Rough, hard particles: sand or gravel. 4) Degree of hardness with openness of texture or composition: allied to buhrstone and the like.

Gumbo — 1) A name current in Western and Southern States for those soils that yield a sticky mud when wet (Southwest MO). A putty-like clay associated with lead and zinc deposits (TX). A clay encountered in drilling for oil and sulphur. 2) The stratified portion of the lower till of the Mississippi Valley.

Gypsum — Hydrous calcium sulphate. ($CaSO_42H_2O$) Contains 32.5 percent lime, 46.6 percent sulphum trioxide, and 20.9 percent water. Some crystals are 3 or 4 feet long and clear throughout.

Hematite — Hematite is a compound of ironand oxygen (Fe_2O_3) which may be either red or earthy or black with a dull or metallic luster. Both types have a red-brown or Indian-red streak by which the mineral is readily identified. The earthy variety marks paper easily.

Hemimorphite — Hemimorphite, sometimes called calamine is a silicate of zinc containing water. Its chemical formula can be written H_2ZnSiO_5. It is a white mineral which is found in radiating crystal groups and in globular forms. Its hardness is such that it can be scratched by a knife but not by a penny. Hemimorphite usually occurs with zinc ores.

Hornblendite — A granitoid, igneous rock, consisting essentially of hornblende and analogous to pyroxenite. (Kemp).

Ilmenite — Ilmeniteis an iron black mineral composed of iron, titanium, and oxygen ($FeTiO_3$). It makes a brownish-black streak and it cannot be scratched by a knife. Most large specimens of ilmenite are dense, granular masses, but the mineral may occur as platy crystals and as grains in sand. Where ilmenite is mined as an ore, as in New York State it is desired for its titanium content. The titanium, as the oxide, is used in paint manufacture.

Jasperoid — Jasperoid is metamorphosed sedimentary rock in which the lead and zinc ores of the Tri-State mining area of Kansas are commonly found. A gray to black mottled chert, coarser grained than ordinary chert, it is the cementing material around angular pieces of the original

light-colored broken chert.

Jaw Crusher — A crusher which breaks material by squeezing it between two jaw plates, one movable and one stationary.

Jet Piercing — Method of making blastholes on iron ranges. Combustion of kerosene and oxygen makes hot flame which spalls rock.

Jig — A machine for making gravity separation in water on a pulsating screen.

Kaolin — A very pure white clay, used to form the paste of porcelain. Paper, rubber, refractories, and pottery industries are the principle consumers, while it is also used with cement, high-grade tile, fertilizers, chemicals, insecticides, paint, linoleum, etc.

Kyanite — (Data is restricted) Var. of cyanite. Mined commercially in Virginia and Carolina.

Lake or Beach Sands — Fine granular sand composed chief of round, smooth particles, and are usually blended with coarse sands to complete the gradation for bituminous construction.

Lava Rock — When volcanoes erupt quietly instead of explosively, molten rock pours out in a thick, liquid state. The solidified material formed by cooling of the lava commonly has a ropy appearance; it is a dark fine-grained rock called lava rock. Boulders and pebbles of lava rock occur in stream deposits and in boulder clay and related deposits of some glaciated regions.

Lift — Depth, or thickness, of soil layers added in a compacted fill section. Each lift is compacted to specifications before the subsequent lift is added. This lift thickness is limited to the depth to which the compacting equipment will compact.

Lime — An alkaline earth consisting of the oxide of calcium. Artificially made by calcining or burning limestone or marble. Lime made from dolomite limestone contains a considerable percentage of magnesia and is slower setting.

Lime Rock — Any rock or stratum in which limestone is a prominent ingredient. Limestone.

Limestone — The general name for sedimentary rocks composed essentially of calcium carbonate.

Limestone and Dolomite — Limestone and dolomite are two very closely related rocks. The former, in a pure state, consists of grains of the mineral calcite and the latter of grains of the mineral dolomite. To be scientifically correct, the term dolomite should be used only when speaking of the mineral, but through common usage dolomite as a rock is now generally accepted.

Calcite consists of calcium carbonate and is one of the most common minerals known. The mineral dolomite is made of calciummagnesium carbonate and is also quite common. These two minerals are often found together in the same deposits and whether the rock is classed as a limestone, a dolomitic limestone, or a dolomite depends on the proportion of each mineral. The two minerals can be told apart by the way hydrochloric acid reacts on each. Cold dilute hydrochloric acid will fizz when it is put on limestone; in order to react in the same manner with dolomite, either the dolomite must be powdered or the hydrochloric acid must be heated.

Pure limestones are white or almost white. Because of impurities such as clay, sand, organic remains, irons, and other materials, many limestones exhibit different colors, especially on weathered surfaces. Limestones may be crystalline or granular depending on the method of formation, and crystals of calcite, quartz,

or dolomite may line small cavities or geodes in the rock. Chert balls or nodules are common in limestone, layers.

Limonite — Limonite, a compound of iron, oxygen and water ($2Fe_2O_3H_2O$) is a yellowish-brown to dark brown or black noncrystalline mineral. It is formed by the alteration of other minerals that contain iron. Limonite has a characteristic yellow-brown streak but its hardness depends on the form in which it occurs. The yellow-brown earthy form of limonite, really a mixture of limonite and clay, called yellow ochre, is so soft that it easily leaves a mark on paper. The dark brown to black variety (bog iron ore) is so hard it cannot be scratched by a knife. Small quantities of limonite give a yellowish or buff color to most sandstones and to many clays, shales, and limestone. As a scum on quiet water, it may be mistaken for oil. It is an iron ore of minor importance in some states.

Liquid Limit — As indicated by the name, it is the lowest moisture content at which the soil tends to flow when disturbed slightly: the change from plastic to liquid and is expressed in percentage of water by weight to the weight of dry soil.

Lithum — (Chem.) — A soft silver-white metallic element. Spodument is recovered in North Carolina, South Dakota and Maine. Crude sodium lithium phosphate is produced in California. Amblygonite is mined in South Dakota, and lepidolite in New Mexico. Other lithium minerals are under investigation. It is used for lithium greases, ceramics, porcelain elements and glass.

Load Carrying Capacity or Bearing Ratio Test — This test is the percentage comparison of loads required to force penetration of a piston an equal distance into the sample being tested as against a specified standard. The common measure is known as the California Bearing Ratio (CBR) for which the standard of compadson is a compacted crushed stone.

Loess — In geology, a yellowish-finegrained, slightly calcareous, loamy clay, commonly unstratified but having same vertical jointing, believed to be a deposit of windblown dust. (La Forge).

Magnesite — Native magnesium carbonate, $MgCO_3$. Purities range from 82 to 96 percent MgO. Domestic supply is deemed sufficierff for the normal needs of the steel, metallurgical and miscellaneous refractory trades, which use magnesite in the form of grain, mortars, ramming mixes and brick. Brine-dolomite and other brine magnesite production now totals about half the national potential. Calcined magnesite products are used for insulation, chemical, building and fertilizer purposes.

Magnetite — Magnetite (iron oxide Fe_3O_4) is so named because it is readily attracted by a weak magnet and because some magnetic specimens called lodestones are, in themselves, magnets. The mineral is black, has metallic luster and makes a black streak. It is so hard that it cannot be scratched by a knife. It is found as granular masses but especially in igneous rocks, it commonly occurs as individual crystals, most of which have eight triangular faces and are called octahedrons. Magnetite is an important ore of iron. Occasional grains of magnetite may be found in many river sands.

Marble — In lithology, a metamorphosed and recrystallized limestone. In the trade, the name is applied to any limestone that will take a polish. The following are some of the principle marbles: bardiglio, bird's eye, black and gold, boagard, breccia, calico, campan, cipolino, eolian. fior di persicor, fire, forest, griotte, landscape, lumachelle, mischio, nero antico de prato,

onyx, porter, rosso antico, ruin, St. Anne, St. Baume, stalactitic and stalagmitic statuary, verdantique and winooski.

Marcasite — Marcasite, sometimes called white iron pyrite, is a mineral composed like pyrite or iron sulfide (FeS_2). On fresh surfaces, it is pale yellow to almost white and has a bright metallic luster; it tarnishes to a yellowish or brownish color and gives a black streak. It is a brittle mineral which cannot be scratched by a knife. The thin, flat, tabular crystals when joined in groups are called "cockscombs". When combined into balls or nodules, or into more complicated groups, they make marcasite rosettes. The mineral can be distinguished from pyrite by its lighter color and by its crystal form. Marcasite weathers readily to form limonite, and melanterite.

Materials Handling — Methods of transporting broken or crushed ore from one point to another.

Meerschaum - Also Called sepiolite, this lighweight white clay mineral is used mostly in making smoker's requisites, pipes, etc. There are scattered deposits in the United States. It has potential use as electrical insulation, toothpaste, oil absorbent, etc.

Melanterite — Melanterite, or copperas, is a suliate of iron with water ($FeSO_47H_2O$) occurring as very fine, fibrous masses that are hard to preserve. It is greenish-white to white and has a sweet, metallic, bitter taste. It is formed by chemical action on pyrite or marcasite under damp conditions, such as on the walls of underground mines and in coal seams.

Mica — Mica is the name of a group of several minerals which are unusual because they split into thin, flat, flexible, or elastic sheets. The type of splitting is due to the fact that micas have one perfect cleavage. They are composed of aluminum silicates of many elements. Muscovite, or common "white" mica is transparent and colorless. It can be seen as tiny, flat, shining flakes in sandstones, siltstones, and shales, and as small crystals in boulders of metamorphic and igneous rocks. Biotite (black mica) may be seen in some tertiary and quaternary sands. The color of biotite is caused by iron. Phlogopite mica is yellowish-brown, has a copper-like luster on the clevage surface and often is mistaken for flakes of gold.

Mineral Dust — A finely powdered rock dust, Portland Cement, or other artificially or naturally powdered mineral dust, 80% to 100% of which will pass a No. 200 mesh sieve.

Mineral Earth Pigments — Pigments used in paints follow closely the construction picture in production. The natural mineral iron-oxide group, prepared for market by washing, drying, grinding, blending and calcining, account for 55 percent of the total. Chemically manufactured iron-oxide pigments (referred to as pure or synthetic), produced by calcination or controlled oxidation, make up the rest.

Hardness of Minerals — Some minerals are very soft; others are very hard. The degree of hardness is an aid in identifying the minerals. Diamonds are harder than quartz and will therefore, scratch quartz; quartz will scratch calcite; calcite will scratch gypsum and so on. An easy way of estimating the hardness of a mineral in the field is by trying to scratch it with such common objects as a fingernail, a copper penny, a pocket knife blade, and a piece of window glass. Glass the hardest of the four, will scratch the most minerals, the knife is next in hardness; then in order comes the copper cent, and the fingernail.

Cleavage and Fracture of Minerals — Some minerals when struck a sharp blow, break only along certain lines, while other

minerals break just as easily in one direction as in another. When a mineral has a tendency to break along certain planes, it is said to have cleavage, which is the result of the arrangement of the molecules and atoms. Minerals may have only one plane of weakness or cleavage, or they may have two, three, or more. The second type of breaking, that which is not determined by any arrangement of molecules is called fracture and this also varies among different minerals. Various types of fractures are described as smooth, uneven, ragged, and shell-like.

Mineral Wool — Produced from rock, slag and glass, this insulating material has been growing in use. Major fields of use include structural insulation, equipment insulation and industrial insulation.

Natural Moisture Content — The plastic limit and liquid limit which are expressed as a percentage of water by weight to the weight of dry soil.

Near Size — Material less than 1.5 times and more than 0.5 times the width of the screen opening.

Nepheline Syenite — This quartz-tree crystalline rock consisting mostly of nepelite albite and microcline feldspar is found in New Jersey, Arkansas and other states, but usually has too much iron for ceramic purposes.

Obsidian — 1. Extrusive igneous rocks which have cooled either without crystallization or with only partial crystallization. (U.S. Geol. Surv.) 2. A general name for volcanic glass. When used alone it implies a rhyolite-glass, but it is now much employed with a prefix as andesite-obsidian, basalt-obsidian. (Kemp)

Olivine — Comprising fayalite, olivine and forsterite, this mineral group is found in many rocks. Large concentrations, called dunite, are mined or quarried commercially in North Carolina and Washington to make retractory brick and cements and foundry sand.

Oolite — A rock consisting of small round grains, usually carbonate of lime, cemented together.

Opal — Opal consists of silicon dioxide, like quartz, plus an indefinite amount of water (SiO_2-nH_2O). It never forms as crystals, but probably is deposited as a jellylike substance which later hardens. The mineral may be white, yellow, red, brown, green, gray, blue or transparent and colorless. Precious opal shows a beautiful display of colors and is highly prized as a gem stone. Opal cannot be scratched by a knife, but is slightly softer than quartz. It is found as a lining or tilling in cavities in some rocks, as a deposit formed by many hot springs, and as the petrifying material in much fossil wood.

Optimum Moisture — Percentage by weight of water at which the maximum density can be obtained on a sample by prescribed compacting procedure. It will, therefore, vary with the method used.

Overburden — The waste which overlies the good stone in a quarry. Worthless surface material covering a body of useful mineral.

Oxidized Asphalt — Asphalt which has had certain of its natural characteristics changed or modified by blowing air through it at an elevated temperature. For this reason often called blown asphalt. Oxidized asphalt has a higher melting point than asphalt of the same consistency produced only by evaporation or distillation of petroleum.

Particle — An individual piece of rock, gravel or other material in the screen feed.

Pass — A pass refers to one passage (oneway) of compacting equipment over

the area being compacted.

Pavement Structure — All courses of selected material placed on the foundation or subgrade soil. other than any layers or courses constructed in grading operations.

Pea Gravel — Any clean gravel, whether bank or river gravel, having a gradation of from 1 /4-inch to 1 /2-inch or which approximate a pea in grain size.

Peat — Semi-carbonized vegetable tissue formed by partial decomposition in water of various plants, esp mosses of the genus Sphagnium. Used in this country for soil improvement and mixed fertilizers.

Pebbles — 1) A small, roundish stone, especially one worn round by the action of water; a pebblestone; also a gem occurring in the form of pebbles. 2) Transparent colorless quartz; rock crystal; as Brazilian pebble.

Pegging — Obstruction of an opening by a particle becoming struck in the opening it has entered but cannot pass through.

Peridotite — A granular igneous rock composed essentially of olivine, generally with some form of pyroxene, and with or without hornblende, biotite, chromite, garnet, etc. (La Forge)

Perlite — 1) Volcanic glass with concentric, shelly texture and usually with a notable percentage of water. 2) Also called earlite or Pearlstone. A eutectoid of cementite and crystallized iron formed by slow cooling of molten steel.

Phosphate Rock — A rock consisting of calcium phosphate, usually together with calcium carbonate and other minerals, used in making fertilizers.

Plastic Limit - The lowest percentage of water that will allow rolling a sample to 1/8 inch diameter without crumbling. For all practical purposes it does not exist in noncohesive soils. As the name implies, it is the point where a soil is changing in characteristic from solid to plastic and is given in terms of percentage of water by weight to the weight of dry soil.

Plasticity — The physical property of a fine-grained soil (clay) which allows it to be kneaded into a putty-like consistency of the proper moisture content.

Plasticity Index — The difference between the plastic and liquid limits. Generally speaking, a low index indicates good compacting qualities, and for non-plastic soils in zero.

Primacord — Trade name for instantaneous fuse.

Proctor Compaction Test — The density to which a soil may be compacted with a given compaction method varies with its moisture content. The moisture content which gives the greatest dry unit weight is known as the optimum moisture content for that method of compaction. A laboratory test for this determination was developed by R.R. Proctor and is known as the Proctor Compaction Test.

Modified Proctor or Modified A.A.S.H.O. Test — Greater densities which have been obtained by improved compacting equipment in recent years has necessitated development of laboratory tests to reproduce these higher field densities. This newer test procedure is known as the Modified A.A.S.H.O. (Amer. Assoc. State Highway Officials), or Modified Proctor. The differences are shown in the following table:

Test Methods	Vol. of Test Cyl.	Dia. Test Cyl.	Num. Layers Soil	Num. Blows Layer	Wt. of Hammer	Height of Free Fall
Standard Proctor	1/30 Cu. Ft.	4"	3	25	5-1/5 Lbs.	12"
Mod. proctor or Mod. A.A.S.H.O.	1/30 Cu. Ft.	4"	5	25	10 Lbs.	12"

Psilomelane — Psilomelane is an oxide of manganese (MnO_2). It is a black mineral that makes a very dark brown to black streak, is much harder than pyrolusite; it cannot be scratched by a knife. An earthy form of psilomelane, however, is known as wad, and it is soft enough to soil the fingers. Wad forms the coating around some pebbles in gravel deposits, and it also occurs as soft black lumps in gravels.

Pumice — An excessively cellular, glassy lava, generally of the composition of rhyolite (Kemp). A sort of volcanic froth. Its color is generally whitish or light gray. It is very light and will float on water. Pumice stone.

Pyrite — Pyrite (iron sulfide, FeS_2) is a pale, brass yellow, opaque mineral that is brittle and has a metallic luster. It makes a black streak and is so hard that it can scratch glass. Many pyrite crystals are cube-shaped like galena, but they also occur in other forms. Pyrite is also found as granular masses, as cones and globules, and as nodules in shale, limestone and sandstone. It is called "fool's gold" because it is yellow; but pyrite is brittle, has a greenish tinge, and tarnishes, whereas gold is softer, leaves a yellow streak instead of a black one, and does not tarnish easily. Pyrite occurs in rocks of all ages, and is abundant in some coal deposits and veins. It is also found with gypsum in the dark shades. It is produced as a by-product of coal near Pittsburgh and is used in making sulfuric acid.

Ouartz — Quartz, the most common of all minerals, is composed of silicon and oxygen (CiO_2) and is found in many different varieties. When pure, it is colorless but it also assumes various shades of yellow, pink, purple, brown, green, blue, or gray. One of the hardest of minerals, it will easily scratch window glass. It has no good cleavage and has a glassy to greasy luster.

There are two main types of quartz, the coarsely crystalline and the fine or cryptocrystalline forms. The crystals of the first type are six-sided prisms with pyramids capping one or both ends. Well-formed, colorless quartz crystals of this type are found in geodes and as linings on the inside of some fossils. Quartz crystals with a bluish cast are found in some granites. Nearly all sands and sandstones are composed of tiny worn particles of crystalline quartz.

The second main type of quartz is called cryptocrystalline because the crystals are so small that they cannot be seen without a microscope. One of the best known varieties in this group is flint or chert. Chert is dull gray, brown, or black. It breaks with a shell-like fracture and the edges of the broken pieces are sharp. Chalcedony is a cryptocrystalline quartz with a waxy luster that forms banded layers or globular masses. Agate is a many-colored form of chalcedony which has been deposited in cavities or veins.

Quartzite — Quartzite is a rock consisting of quartz sandstone so thoroughly cemented with silica that the rock breaks through the grains as easily as around them. It is distinguished from sandstone not only because it breaks through the grains, but also because it cannot be scratched with a

knife. Quartzites may be either metamorphic or sedimentary in origin and the two types are so similar in appearances that in many cases they cannot be told apart.

Metamorphic quartzites are caused by intense folding of the rock or by solutions from nearby igneous intrusions or both.

Quartzite boulders are common in the boulder clay of the glaciated area. The rock making up these boulders is red, brownish-red, or purple, and it breaks with a splintery fracture. Quartzite, because it is so hard and resistant, can be used as a railroad ballast and in the construction of dams. It is used in some places as road material and as building stone.

River Gravel — Found in almost any stream or river and consists of partly rounded and smooth fragments of rock intermixed with river sand and is usually free from clay and silt. That part. consisting of particles larger than 1/4 inch is classified as river gravel.

River Sand — Due to action of water and the rolling of one particle of sand over another, does not have a high percentage of sharp angular grains and is usually free from clay and very fine sizes.

Rhyolite — A felsophyric to vitreous igneous rock composed essentially of quartz and alkali feldspar, or of rock glass having substantially the same composition, with or without biotite, hornblende, or pyroxene; liparite. (La Forge) Rhyolite is current in America, whereas liparite and quartz-trachyte are more used abroad. A lava, usually of light color, corresponding in chemical composition to granite. The same molten liquid that at great depth within the earth solidifies as granite would, if it flowed out on the surface, cool more quickly and crystallize less completely as rhyolite (Ransome)

Roll Crusher (Double) — A crusher which breaks material by squeezing it between two revolving metal cylinders. with axes parallel to each other and separated by a space equal to the desired size of finished product.

Salines — Chemical salts in their natural state are recovered by mining, brine saturation and other methods. A score or more types of sodium compounds exist in minerals, some mined in large quantities. See boron, bromine, calcium chloride, salt, sodium compounds, magnesite, etc.

Salt — Sodium chloride (NaCl) — Any of a class of compounds formed when the acid hydrogen of an acid is partly or wholly replaced by a metal or a metal-like radical.

Sands and Sandstones — Sands are loose, unconsolidated rocks having particle sizes between those of silt and pebbles(1/16mm to 12mm). When held together by chemical cement or by clay, they are called sandstones. These rocks result from the breaking down or weathering of older rocks, and from the transportation and sorting of the rock fragments by moving water or by wind.

Sand mostly consists of grains of quartz, but some of it may contain large amounts of feldspar. Sand occurs almost everywhere along large stream valleys, in regions of old glacial drainage or out wash.

Sandstones, like sand, consist largely of quartz grains, but sandstones are held together by some natural cement or matrix such as calcium carbonate, iron oxide. or clay, and the rocks can be classified according to the type of cement. Interesting collections of sandstones in which the grains are cemented by different types of material have been made. In places, sandstone occurs interbedded with shale and limestone, in other places, it occurs as channel deposits cutting through shale and limestone. Sandstone that is buff or brownish in color is cemented with iron oxide. There are areas of sandstone cemented by calcite (calcium carbonate) in crystals so large that wide areas of rock reflect light in a manner known as"luster mottling. This rock is sometimes called "quartzite" because it is very hard, but it is not a true quartzite. In other areas. soft, crumbly sandstones from the cretaceous age form

cliffs and box canyons.

Sand Asphalt — It is either: 1) A hot-laid plant mix mixture of local sand and asphalt cement prepared without special control of aggregate grading: or 2) A mixture of local sand, with or without mineral filler, and a liquid asphaltic material. In the latter case, either road mix or plant mix construction may be employed. Sand asphalt is used in low-cost construction for both base and surface courses. It is known as the fine aggregate type of mixture.

Sand Clay — (Road Surface) A surface composed of a mixture of sand and clay where the two materials have been blended, so that their opposite qualities tend to maintain a condition of stability, under varying moisture content. Some deposits are found in nature, but the bulk of such surfaces are prepared artificially.

Sandstone — An indurated sedimentary rock formed of coherent or cemented sand. The following are common varieties: Asphaltic sandstone, Bluestone, Brownstone, Building sandstone, Flagstone and Freestone.

Scalping — An operation in which 85 to 95 percent of feed material is considerably smaller than the screen opening.

Scalping Screen — A vibrating or revolving screen which separates various sizes of materials for delivery to one or more crushers and bypasses small sizes around the crushers.

Serpentine — 1) In mineralogy, a hydrous magnesium silicate ($H_4Mg_3Si_2O_8$), commonly green, greenish-yellow, or greenish-gray, and massive, fibrous, lamellar, or occurring as pseudomorphs. It is an important constituent of some metamorphic rocks and is everywhere secondary, after olivine, amphibole, pyroxene, etc. 2) In petrology, a metamorphic rock composed chiefly or wholly of the mineral serpentine. (La Forge)

Schist — A crystalline rock that can be readily split or cleaved because of having a foliated or parallel structure, generally secondary and developed by shearing and recrystallization under pressure. (La Forge)

Screenings — Fine material that passes through a screen when screening for lump material.

Screening Efficiency — Ratio of screen undersize actually passing the screen openings to the total undersize in the feed.

Shale — A hardened, compacted clay or silt which breaks along bedding planes is called shale. The particles that make up a shale are too small to be seen without a microscope. Shales have a leaflike bedding and weather into thin slabs or plates, some of which are no thicker than paper. When shales weather, they form clays or muds. Shales and clays are easily eroded or worn away. Consequently, the best exposures are found underneath ledges of harder, more resistant rocks such as limestones and sandstones. Most shales are soft enough to be cut with a knife and are rather brittle or crumbly. The usual color is gray, but black, green, red, or buff shales are common. Many shales contain nodules of pyrite selenite crystals, or in concretions of various forms. Shale and clay together make up about 80% of the sedimentary rocks of the earth's crust. Some black, very thin bedded shales are often called slate because they have the same color as many slates and because they break into thin, hard platy sheets. Slate, however, is a metamorphic rock formed when shale is put under great heat and pressure.

Shell — The term " Shell Aggregate" applies to oyster, clam shells, etc., used for road surfacing material. These shells are crushed in an ordinary stone crusher. It is difficult to crush this material to a given specification, and it does not produce a strong pavement unless a suitable gradation is produced through the introduction of other aggregates, such as sand and stone.

Siderite — Siderite, which is a common mineral, is composed of iron carbonate ($FeCO_2$). It is light to dark brown, and some of it occurs as rhomb-shaped crystals with curved faces (like dolomite). Most siderite is

granular or earthy. The mineral cannot be scratched by a knife. It fizzes in hot hydrochloric acid, but reacts slowly in cold acid. Weathered surfaces change to limonite and turn dark brown.

Silica — An oxide of silicon, ($SiO2$). Occurs in nature as a mineral of economic importance in quartz, chalcedony, chert, flint, opal, diatomaceous earth and sandstone. The most abundant constituent of the earth's crust. See also Agate, Quartz. Also known as silex, and used for lining tube mills.

Silt and Sandstone — Silt is a common sedimentary rock composed of tiny particles smaller than sand size, yet larger than clay size (1/16mm to 1/256mm). It is found in stream deposits and lake beds, but it occurs chiefly as a windblown deposit called loess. It is typically a yellowish buff porous silt that crops out with steep faces along hillsides and valley walls. Much loess contains white or cream colored concretions an inch or two in diameter, which are composed of calcium carbonate and have been called Kindchen (little children) of the loess. Small white shells of snails may also be found in the loess.

Some of the finest and thickest soils in the world are formed in the upper part of thick deposits of loess. As wind moves small particles only, a soil built up from deposits of this kind is free from rocks and large pebbles. Loess deposits have been built up by successive dust storms.

Consolidated or compacted silt is known as siltstone. This rock may be found as thin, slabby beds in many of the Pennsylvanian formations. Many siltstones and fine sandstones contain layers rich in tiny flakes of mica, which glitter in the sun. The mica is concentrated along the bedding places where the rock breaks easily.

Sizing Screen — A vibrating or revolving screen which separates various sizes of materials for delivery as finished products into hoppers, trucks or onto conveyors.

Slag — A by-product of blast furnace operation. A good quality slag makes an excellent paving material and can be crushed into almost any gradation, although most slags are quite porous.

Slates — A dense, fine-textured metamorphic rock whose separate minerals are indistinguishable to the unaided eye, and which has an excellent parallel cleavage, so that it breaks into thin plates or pencil-like shapes. A coal miner's term for any shale or slate accompanying coal, also sometimes applied to bony coal.

Slope Stability — Degree to which overburden or rock maintains a particular grade or angle when open to the elements.

Sludge — Mixture of drill cuttings and water from drill holes. Used for sampling ore grade or for stemming blastholes.

Slurry-Type Explosive — Viscous explosive charged into plastic bags to fill contour of drillhole (new).

Smithsonite — Smithsonite (zinc carbonate, $ZnCO_3$), is commonly brown in color, but it maybe green, blue, pink, or white. Although it does occur as rough, curved, rhomb-shaped crystals, its occurrence as rounded globular forms or as honeycomb masses is more common. Smithsonite is harder than most carbonate minerals; it cannot be scratched by a penny, but it can be scratched by a knife. It fizzes in cold hydrochloric acid.

Sodium compounds — Natural soda ash, and trona used in many industries as sodium carbonates are produced in California and Wyoming.

Sphalerite — Sphalerite, also called zinc blende, black jack, and mock lead, is composed of zinc sulfide (ZnS), and is the most important ore of zinc. Sphalerite when pure is nearly colorless, but it is commonly brown, yellow. black, or dark red because of impurities. It has a white to dark brown streak, which is always much lighter than the color of the specimen. As a rule, the

mineral crystals are shaped like triangular pyramids, with three sides and a base: because it has good cleavage in six directions, sphalerite will break into twelve-sided blocks. It has a brilliant, resinous, or almost metallic luster, and is harder than a penny but can be scratched with a knife. Some sphalerite is found as massive deposits varying from coarse to fine-grained. In hydrochloric acid it dissolves and forms hydrogen sulfide which has an unpleasant odor. Sphalerite is easily identified by its cleavage and resinous luster.

Springing — Enlarging blasthole by small preliminary blast.

Spudding-In — Starting a drill hole.

Steam Refined Asphalt — Asphalt which has been refined in the presence of steam during the distillation process.

Stemming — Material used to confine explosives in hole, such as drill cuttings or water.

Stone — Concreted earthy or mineral matter. A small piece of rock. Rock or rock-like material for building. Large natural masses of stone are generally called rocks; small or quarried masses are called stones; and the finer kinds, gravel or sand.

Stone-Sand - Refers to the product (usually less than 1 /4-inch in dia.) produced by the crushing of rock. This material is usually highly processed, and should not be confused with screenings.

Stripping — Removing waste overlying ore body.

Sub-Grade — The upper surface of the native foundation on which is placed the road material or artificial foundation, in case the latter is provided.

Sub-Soil — 1) Broadly and loosely, the part of the regolith (earth mantle) which lies beneath the true soil and which contains almost no organic matter. 2) More precisely, a layer of the regolith, grading into the soil above and into unmodified rock waste below, which is less oxidized and hydrated than the soil proper and contains almost no organic matter, but is somewhat charged with and indurated by iron oxides and clay that has been leached down from the overlying soil.

Syenite — Any granular igneous rock composed essentially of orthoclase, with or without micracline, albite, hornblende, biotite, augite, or corundum. (La Forge). In mica syenites hornblende is replaced by biotite and in augite syenites it is replaced by augite. If a small quantity of quartz is present, it is called quartz syenite. In nepheline syenite the feldspar is partly replaced by nepheline. (U.S. Geol. Surv.)

Toe — Burden of rock between bottom of blasthole and free face.

Topsoil — (Road Surface). A variety of surfacing used principally in the southeastern states, being the strippling of certain topsoils which contain a natural sand-clay mixture. When placed on a road surface, wetted and puddled under traffic it develops considerable stability.

Trachyt — Any aphanitic, aphanophyric, or glassy igneous rocks composed essentially of alkali feldspar, with or without mica, amphibole, pyroxene, and the other accessories, or of rock glass having essentially the same composition. (La Forge). It was formerly used for both rhyolite and trachyte proper, as a field term for light-colored lavas and porphyries. Compare Acmitetrachities and Pantellerites. (Kemp).

Trap — Includes the dark-colored, fine-grained and dense igneous rocks composed of the terro-magnesian minerals, basic feldspars, and little or no quartz. The ordinary commercial variety of trap is basalt, diabase, or gabbro.

Tripper — A mobile mechanical device for continuously discharging and distributing aggregate from a belt conveyor into a line of bins or stockpiles.

Tuff — A sedimentary rock composed of fine material—volcanic dust, so-called ash and cinders and lapilli—explosively ejected from a volcano. Tuff may or may not be deposited in water; it may be either heterogeneous or rather well sorted, and it may be either incoherent or indurated. (La Forge).

Undersize — Those particles small enough to pass through the screen openings.

Uranium — (Chemical) — A radioactive element of the chromium group, found in combination in pitchblende and certain other rare materials, and reduced as a heavy, hard, nickle-white metal.

Volcanic Ash — Volcanic ash or volcanic dust (in some places called "silica" although this name is not exactly accurate) consists of tiny glass or congealed lava fragments which have been blown into the atmosphere during the eruptions of volcanoes. It is a type of extrusive rock, that has been forced out or extruded onto the earth's surface. Under a microscope or a hand lens, ash is seen to contain small curved pieces of glass which are the broken walls of bubbles of the lava rock which burst from the volcano. Ash can easily be distinguished from other rocks, principally sand, by its white to bluish-gray color. Its glassy surfaces sparkle in the sun, and its particles do not dissolve in acid as do particles of limestone and chalk. It is used for many purposes; in toothpastes and powders, as abrasives, cleaning compounds, glazes for pottery, in filters, and in the manufacture of cement and road asphalt.

Wagon Drill — Compressed-air rock drill on wheels or"cat" tracks.

Wedging — Same as pegging.

PHYSICAL PROPERTIES OF AMERICAN ROCKS

Name of Rock Specimen	Location Found	Hardness Shore Number	Coefficient of Thermal Expansion Room Temp. to 212°F	Maximum Compressive Stress, Lb. Per Sq. In.	Maximum Compressive Stress, (BARS)	True Specific Gravity	Apparent Specific Gravity	Wt. Lb. Per Cu. Ft.	Wt. Kgs/Cu. Meter	Absorption, Percent	Pores, Percent	Solids, Percent
IGNEOUS ROCK												
Rhyolite-Granite Series												
Felsitic Rhyolite	Mojace, CA	86.0	41×10^7	17,250	1173	2.59	2.49	155.2	2486	1.67	4.13	95.9
Rhyolite Breccia	Animas Forks, CO	101.4	45	42,500	2891	2.65	2.62	163.8	2624	0.41	1.02	98.9
Granite Porphyry	Winchester, MA	78.7	34	17,700	1204	2.67	2.65	165.2	2647	0.27	0.70	99.3
Binary Granite	Concord, NH	94.4	49	25,800	1755	2.68	2.57	160.4	2570	1.55	3.98	96.0
Biotite Granite	Picton Island, NY	103.7	36	34,500	2347	2.64	2.61	163.0	2611	0.36	0.94	99.1
Biotite Granite	Cripple Creek, CO	97.0	19	25,900	1762	2.60	2.57	160.7	2574	0.48	1.19	98.9
Biotite Granite	Westerly, RI	91.8	47	20,650	1405	2.63	2.60	162.4	2602	0.39	1.00	99.0
Biotite Granite	Westerly, RI	99.1	*	19,930	1356	2.65	2.63	164.2	2630	0.34	0.88	99.1
Biotite Granite	Barre, VT	95.2	52	28,500	1939	2.65	2.63	164.2	2630	0.34	0.88	99.1
Biotite Granite	Llano Co., TX	91.1	39	23,500	1599	2.66	2.64	165.0	2643	0.20	0.44	99.5
Biotite Granite	Spring Creek, CO	84.6	*	8,830	600	2.61	2.63	158.2	2534	1.13	2.87	97.1
Biotite Granite (Granitite)	Woodbury, VT	98.9	38	25,380	1726	2.65	2.63	164.0	2627	0.38	0.97	99.0
Biotite Muscovite Granite	Georgetown, CO	97.4	66	27,500	1871	2.68	2.67	166.6	2669	0.21	0.53	99.4
Biotite Muscovite Granite	Peekskill, NY	85.1	*41	18,000	1225	2.60	2.58	161.2	2582	0.25	0.64	99.3
Biotite Muscovite Granite	Mount Airy, NC	96.9	45	24,700	1681	2.62	2.60	162.1	2597	0.38	0.98	99.0
Alkali Granite	Quincy, MA	75.4	29	19,200	1306	2.67	2.64	164.8	2640	0.36	1.01	99.0
Alkali Granite	Quincy, MA	100.5	58	22,600	1538	2.64	2.62	163.6	2621	0.38	0.88	99.1
Aplite	Boulder Co., CO	71.3	50	20,750	1412	2.61	2.50	156.1	2501	1.67	4.11	95.8
Flourite Granite	Clinton Co., NY	50.9	56	13,250	902	3.04	2.99	186.0	2980	0.58	1.67	98.3
Spring Creek Granite	Cripple Creek, CO	85.6	37	22,200	1510	2.60	2.54	158.5	2539	0.92	2.63	97.7
Hornblende Granite	Fredericksburg, TX	83.1	37	25,800	1755	2.63	2.61	162.8	2608	0.36	0.89	99.1
Amphibole Granite	Hurricane Island, ME	100.5	60	23,700	1613	2.64	2.62	163.5	2619	0.32	0.79	99.2
Trachyte-Syenite Series												
Quartz Syenite	Ticonderoga, NY	70.1	37	21,600	1470	2.67	2.63	164.1	2629	0.62	1.54	98.4
Dacite-Quartz-Diorite Series												
Granodiorite	St. Cloud, MN	98.8	42	29,500	2007	2.71	2.70	168.5	2699	0.19	0.50	99.5
Dacite	San Luis Obispo Co. CA	99.6	28×10^7	23,970	1631	2.55	2.46	153.6	2461	1.44	3.50	96.4

*Data not obtained because of lost or defective specimen.

PHYSICAL PROPERTIES OF AMERICAN ROCKS
(Continued)

Name of Rock Specimen	Location Found	Hardness Shore Number	Coefficient of Thermal Expansion Room Temp. to 212°F	Maximum Compressive Stress, Lb. Per Sq. In.	Maximum Compressive Stress, (BARS)	True Specific Gravity	Apparent Specific Gravity	Wt. Lb. Per Cu. Ft.	Wt. Kgs/Cu. Meter	Absorption Percent	Pores, Percent	Solids, Percent
Andesite-Diorite Series												
Hornblende Andesite	Mount Shasta, CA	73.7	23 x 10^7	13,610	926	2.49	2.22	138.8	2223	4.86	10.77	89.2
Andesite Porphyry	Newton, MA	69.4	25	22,400	1524	2.81	2.79	174.3	2792	0.29	0.74	99.2
Andesite Porphyry	Boulder Co., CO	82.7	39	32,700	2225	2.71	2.69	167.8	2688	0.27	0.70	99.3
Andesite	San Juan Co., CO	90.2	57	28,750	1956	2.72	2.71	169.3	2712	0.05	0.10	99.9
Obicular Gabbo Diorite	Davis Co., NC	66.1	*	25,000	1701	3.02	2.97	185.2	2967	0.57	1.67	98.3
Basalt-Gabbro Series												
Hornblende Basalt	Chaffee Co., CO	89.0	26	30,300	2062	2.78	2.77	172.9	2770	0.17	0.44	99.5
Olivine Basalt	Jefferson Co., CO	77.2	22	23,950	1630	2.75	2.74	171.0	2739	0.10	0.22	99.8
Olivine Basalt	Mt. ST. Helens, WA	75.7	33	6,540	445	2.84	2.27	138.2	2214	9.97	22.06	77.9
Basalt Porphyry	Lake Co., OR	75.2	26	18,750	1276	2.81	2.76	172.2	2759	0.66	1.76	98.2
Dolerite Porphyry	Cape Ann, MA	87.5	35	23,600	1606	2.87	2.84	177.5	2844	0.37	1.03	98.9
Fine Grained Diabase	Somerset Co., NJ	96.4	35	38,000	2586	2.95	2.96	184.4	2954	0.06	0.17	99.7
Diabase	Somerville, MA	71.6	31	23,250	1582	2.82	2.85	176.0	2820	0.38	1.00	99.0
Greenstone	Winton, MN	53.8	50	*	*	2.69	2.70	167.7	2687	0.19	0.46	99.5
Bytownite Gabbro	Duluth, MN	80.2	30	*	*	3.00	3.00	187.3	3001	0.00	0.00	100.0
Orthoclase Gabbro Quartz	Wichita Mts., OK	88.8	20 x 10^7	18,600	1266	2.72	2.73	169.6	2717	0.25	0.62	99.3
Orthoclase Gabbro	Duluth, MN	76.5		26,400	1796	2.87	2.86	178.4	2858	0.13	0.29	99.7
SEDIMENTARY ROCKS												
Breccias and Conglomerates												
Syenite Breccia	Boulder Co., CO	83.6	30 x 10^7	27,550	1875	3.12	3.10	193.3	3097	0.27	0.78	99.2
Chert Breccia	Cherokee Co., KS	104.5	67	*	*	2.60	2.56	159.8	2560	0.66	1.65	98.3
Limestone Breccia	Boulder Co., CO	27.3	52	5,960	406	2.80	2.28	142.1	2276	8.26	18.73	81.2
Sandstones												
Argillaceous Sandstone	Portageville, NY	57.2	47	13,900	946	2.65	2.48	155.1	2485	2.48	6.10	93.8
Red (Ferruginous) Sandstone	Potsdam, NY	61.3	57	18,350	1249	2.63	2.49	155.6	2493	2.12	5.26	94.7
Gray Sandstone (Berea Grit)	Berea, OH	42.0	51	5,840	397	2.66	2.13	132.7	2126	9.36	19.84	80.1
Gray Sandstone	Keeseville, NY	86.5	37 x 10^7	33,350	2269	2.62	2.58	160.9	2578	0.66	1.62	98.3

*Data not obtained because of lost or defective specimen.

PHYSICAL PROPERTIES OF AMERICAN ROCKS
(continued)

Name of Rock Specimen	Location Found	Hardness Shore Number	Coefficient of Thermal Expansion Room Temp. to 212°F	Maximum Compressive Stress, Lb. Per Sq. In.	Maximum Compressive Stress, (BARS)	True Specific Gravity	Apparent Specific Gravity	Wt. Lb. Per Cu. Ft.	Wt. Kgs/Cu. Meter	Absorption, Percent	Pores, Percent	Solids, Percent
SEDIMENTARY ROCKS (Continued)												
Sandstone	Jordan, MN	22.0	56×10^7	4,920	335	2.60	1.91	119.5	1914	13.80	29.40	73.6
Sandstone	Medina, NY	72.7	63	18,270	1243	2.60	2.46	153.7	2426	2.09	5.15	94.8
Brownstone	Somerset Co., NJ	51.3	55	14,100	959	2.52	2.35	146.8	2352	2.92	6.75	93.2
Calcareous Sandstone	Socorro, NM	60.3	65	18,810	1280	2.62	2.31	144.5	2315	5.14	11.85	88.1
Limestone and Dolomites												
Coquina	St. Augustine, FL	*	*	200	15	2.73	1.19	74.0	1185	47.80	56.70	43.3
Limestone	Boulder Co., CO	56.2	40	19,780	1346	2.78	2.67	166.6	2669	1.56	4.10	95.8
Limestone	Onondaga Co., NY	64.2	24	26,900	1830	2.73	2.72	169.7	2719	0.12	0.27	99.7
Coral Limestone	LeRoy, NY	58.5	28	16,780	1142	2.70	2.67	166.2	2667	0.52	1.38	98.6
Coral Limestone	Jeffersonville, IN	57.9	49	14,220	968	2.68	2.66	166.1	2661	0.31	0.75	99.2
Gray Limestone	Valcour Island, NY	58.1	17	19,980	1359	2.71	2.69	167.8	2688	0.25	0.63	99.3
Gray Limestone	Ruth, NV	43.0	48	8,470	576	2.70	2.68	167.4	2682	0.26	0.64	99.3
Encrinal Limestone	Lockport, NY	36.8	68	12,280	836	2.71	2.66	166.1	2661	0.70	1.85	98.1
Encrinal Limestone	Trenton Falls, NY	44.1	56	10,400	705	2.70	2.67	166.4	2666	0.49	1.27	98.7
Argillaceous Limestone	Rochester, NY	66.4	51	23,350	1589	2.80	2.74	170.9	2738	0.80	2.19	97.8
Pale Gray Limestone	Concrete, CO	45.4	24	18,500	1259	2.66	2.54	158.9	2546	1.73	4.36	95.6
Cherty Limestone	Buffalo, NY	96.2	*	*	*	2.65	2.65	165.4	2650	0.08	0.15	99.8
Oolitic Limestone	Batesville, AR	48.0	31	14,520	988	2.66	2.61	163.2	2614	0.70	1.82	98.2
Oolitic Limestone	Bedford, IN	27.9	43	8,210	559	2.66	2.29	143.2	2294	5.97	13.66	86.2
Black Oolite (Fossiliferous)	Milton, PA	59.3	30	20,900	1422	2.72	2.71	169.4	2713	0.14	0.30	99.7
Dolomitic Limestone	Gouverneur, NY	46.6	58	9,230	628	2.74	2.73	170.3	2728	0.12	0.28	99.7
Dolomitic Limestone	Rochester, NY	59.8	58	20,200	1368	2.76	2.65	165.4	2650	1.49	3.89	96.0
Birdseye Limestone	Watertown, NY	64.1	37	18,670	1270	2.72	2.70	168.4	2698	0.27	0.71	99.3
Chocolate "Tenn. Marble"	(Near) Knoxville, TN	45.7	53	14,290	972	2.69	2.68	167.6	2685	0.09	0.19	99.8
Siliceous Rocks												
Diatomaceous Silica	Santa Barbara, CA	17.5	15	477	32	1.93	0.48	30.3	485	154.60	74.90	25.1
Chert	Joplin, MO	97.9	64	86,300	5872	2.59	2.48	155.1	2485	1.69	4.10	95.8
Chemical Precipitates												
Travertine (onyx marble)	Suisun, CA	41.1	62	14,220	968	2.68	2.63	164.3	2632	0.75	1.94	98.0
Travertine (onyx marble)	Great Salt Lake, UT	42.1	44×10^7	16,200	1102	2.65	2.64	165.2	2647	0.09	0.21	99.7

*Data not obtained because of lost or defective specimen.

PHYSICAL PROPERTIES OF AMERICAN ROCKS
(continued)

Name of Rock Specimen	Location Found	Hardness Shore Number	Coefficient of Thermal Expansion Room Temp. to 212°F	Maximum Compressive Stress, Lb. Per Sq. In.	Maximum Compressive Stress, (BARS)	True Specific Gravity	Apparent Specific Gravity	Wt. Lb. Per Cu. Ft.	Wt. Kgs/Cu. Meter	Absorption, Percent	Pores, Percent	Solids, Percent
METAMORPHIC ROCKS												
Gneisses and Crystaline Schists												
Biotite Gneiss	Uxbridge, MA	79.6	34×10^7	12,950	881	2.74	2.68	167.1	2677	0.84	2.23	97.7
Biotite Gneiss	Baltimore, MD	87.2	44	15,640	1064	2.66	2.65	165.8	2656	0.12	0.30	99.7
Biotite Gneiss	Cripple Creek, CO	95.7	13	14,950	1017	2.68	2.65	165.6	2653	0.47	1.15	98.8
Granitiod Gneiss	Salisbury, NC	99.4	42	29,400	2000	2.62	2.61	162.9	2610	0.12	0.32	99.7
Gabbro Gneiss	Ablemarle Co. VA	71.4	43	27,220	1852	3.15	3.12	195.0	3124	0.30	0.86	99.1
Quartzites and Slates												
Baraboo Quartzite	Ableman, WI	93.5	61	33,800	2300	2.65	2.64	164.8	2640	0.12	0.34	99.7
Quartzite	Dell Rapids, SD	97.2	60	23,440	1595	2.63	2.61	162.8	2608	0.25	0.65	99.4
Quartzite	Souix Falls, SD	77.8	*	43,800	2980	2.68	2.67	166.6	2669	0.13	0.40	99.6
Red Slate	Granville, NY	75.3	49	19,100	1300	2.79	2.78	173.6	2781	0.13	0.29	99.6
Gray Slate	Bangor, PA	59.1	45	*	*	2.76	2.71	169.3	2712	0.67	1.84	98.2
Green Slate	Pawlet, VT	58.8	49	17,700	1204	2.77	2.77	173.0	2771	0.00	0.00	100.0
Catlinite	Pipestone Co., MN	30.2	35	18,300	124	2.88	2.78	173.7	2783	1.30	3.62	96.4
Crystalline Limestone and Dolomites												
Crystalline Limestone	Rutland, VT	35.7	27	6,540	445	2.71	2.68	167.3	2680	0.40	1.14	98.8
Napoleon Gray Marble	Phenix, MO	42.5	51	13,180	897	2.71	2.66	165.8	2656	0.77	2.02	98.0
White (Yule) Marble	Marble, CO	38.3	38	*	*	2.72	2.70	168.7	2703	0.19	0.45	99.5
Dolomitic Marble	Lee, MA	46.0	50	24,900	1694	2.88	2.86	178.7	2863	0.29	0.81	99.2
Pink and Gray Banded Marble	Hewitts, NC	55.0	38	15,420	1049	2.74	2.73	170.2	2727	0.14	0.38	99.6
French Gray Marble	Plattsburg, NY	52.5	48	*	*	2.52	2.51	156.5	2507	0.26	0.65	99.4
St. Lawrence Marble	Glouverneur, NY	41.1	45	14,440	982	2.53	2.52	157.5	2523	0.13	0.31	99.7
Pittsford Valley Marble	Florence, VT	42.8	45	*	*	2.50	2.49	155.5	2491	0.19	0.48	99.5
Variegated Dolomitic Marble	Swanton, VT	66.1	44	32,450	2208	2.83	2.82	175.7	2815	0.13	0.40	99.6
Verd Antique	Pyrenees Mts., France	71.4	341×10^7	13,500	9190	2.75	2.73	170.1	2725	0.29	0.76	99.2

*Data not obtained because of lost or defective specimen.

PHYSICAL PROPERTIES OF THE MORE COMMON ROCKS

(Rock and Gravel When Crushed Weighs About 100 Lbs. Per Cu. Ft.)

IGNEOUS ROCKS (Ignis = Fire)		Specific Gravity	Compressive Strength Lbs./Sq. In.	Compressive Strength (BARS)	Absorption %	Abrasion Tests: Toughness	Abrasion Tests: Los Angeles	Abrasion Tests: Deval
Intrusive (Plutonic - named after Pluto - god of the lower regions)	Granite	2.63	25,000	1701.0	0.30	9	41.5	3.7
	Syenite	2.71	26,900	1830.3	0.44	14	38.8	4.0
	Diorite*	2.87	10,000	680.4	0.23	17	-	3.1
	Gabbro*	2.93	41,800	2844.1	0.21	14	14.0	3.4
Extrusive (Volcanic - ejected great heat in the form of lava)	Rhyolite	2.61	39,000	2654.0	0.58	18	16.4	3.6
	Trachyte	2.66	25,000	1701.0	0.99	18	20.7	4.2
	Andesite*	2.63	17,000	1157.0	0.93	18	32.5	3.7
	Basalt*	2.84	47,000	3198.0	0.42	30	16.7	3.0
SEDIMENTARY ROCKS (Sedimentam = Setting)								
Formed by action of water (Siliceous)	Conglomerate	2.64	20,000	1361.0	--	10	-	-
	Sandstone	2.48	22,900	1558.1	1.66	12	58.7	5.4
	Shale	2.66	10,000	680.4	1.05	8	-	8.1
Formed by chemical action (Calcareous - containing lime)	Chert (Flint)	2.47			1.42	12	26.4	9.5
	Limestone	2.63	17,500	1191.0	0.61	8	33.8	5.6
	Dolomite	2.71	21,200	1442.4	1.09	8	27.1	5.9
	Limerock	2.71	5,340	363.3	1.60	5	36.3	17.4
	Caliche	(usually grayish in color - varies from soft to hard)						
METAMORPHIC ROCKS (Meta = Over, Morphe = Form, to change over)								
Formed by contact metamorphism	Gneiss	2.68	23,900	1626.2	0.25	8	41.1	4.3
	Schist	2.74			0.26	9	36.5	5.0
	Marble	2.71	13,600	925.3	0.21	5	54.2	6.8
	Serpentine	2.63	43,000	2926.0	0.74	13	18.5	7.1
	Slate	2.74	21,800	1483.3	0.36	18	-	4.4
Formed by regional metamorphism	Quartzite	2.71 to 2.68	31,000 to 23,000	2109.2 to 1565.0	0.38 to 0.24	19 to 13	26.1 to 30.3	3.6 to 3.9

*Often designated as trap rock.

RELATIVE STRENGTHS OF ROCKS FOR DIFFERENT TESTING POSITIONS

		Compressive Strength				
Name of Rock Specimen	Location Found	In Bed Lb/Sq In (BARS)	On Edge Lb/Sq In (BARS)	On Edge Lb/Sq In (BARS)	Average Lb/Sq In (BARS)	Average Absorption Percent
Limestone	Bedford, IN	8,255 (562)	7,960 (542)	7,840 (533)	8,018 (546)	6.08
Limestone	Mankato, MN	12,520 (852)	12,100 (823)	10,130 (689)	11,583 (788)	3.88
Limestone	Carthage, MO	15,250 (1038)	10,150 (691)	9,540 (649)	11,647 (792)	0.58
Travertine	Marble, CO	10,550 (718)	13,440 (914)	12,320 (838)	12,103 (823)	1.69
Limestone	San Saba, TX	5,400 (367)	5,420 (369)	5,430 (369)	5,417 (369)	9.55
Sandstone	Port Wing, WI	4,520 (308)	5,970 (406)	3,353 (228)	4,614 (314)	10.92
Sandstone	Cleveland, OH	10,740 (731)	8,970 (610)	7,630 (519)	9,113 (620)	8.79
Quartzite	Cumberland Co., TN	26,200 (1783)	23,770 (1617)	22,220 (1512)	24,063 (1637)	1.71
Marble	Knoxville, TN	17,400 (1184)	12,180 (829)	16,470 (1121)	15,350 (1044)	0.11

TOUGHNESS OF VARIOUS KINDS OF ROCK

From Drop Hammer Tests

VARIETY OF ROCK	TOUGHNESS LIMESTONE=1	VARIETY OF ROCK	TOUGHNESS LIMESTONE=1
Fresh Diabase (Trap) Pyroxene Quartzite Sandstone	3.0 2.7 2.6	Chert Calcareous Sandstone Granite	1.5 1.5 1.5
Altered Diabase Fresh Basalt Hornblende Schist	2.4 2.3 2.1	Slate Peridotite Granite Gneiss	1.2 1.2 1.2
Diorite Hornblende Granite Rhyolite	2.1 2.1 2.0	Andesite Limestone Mica Schist	1.1 1.0 1.0
Quartzite Biotite Gneiss Augite Diorite	1.9 1.9 1.9	Amphibolite Dolomite Biotite Granite	1.0 1.0 1.0
Altered Basalt Fedspathic Sandstone Gabbro	1.7 1.7 1.6	Augite Syenite Hornblende Gneiss	1.0 1.0

MOHS SCALE OF HARDNESS

Talc -- 1 Gypsum -- 2 Calcite -- 3 Flourite -- 4	Apatite -- 5 Feldspar -- 6 Quartz -- 7 Topaz -- 8	Corundum -- 9 Diamond -- 10

HARDNESS OF ROCKS

SOFT	MEDIUM	HARD	VERY HARD
Asbestos Rock Gypsum Rock Slate Talc Soft Limestone	Limestone Dolomite Sandstone	Granite Quartzite Iron Ore Trap Rock Gravel	Iron Ore (Taconite) Granite Granite Gravel Trap Rock

TESTS USED TO DETERMINE PHYSICAL PROPERTIES OF ROCK

COMPRESSIVE STRENGTH

1. Sample - cylinder of rock 2" high and 2" diameter.
2. Cylinder of rock is placed between a special bearing block and the head of a suitable universal testing machine.
3. Unit crushing strength is calculated in pounds per square inch.

SPECIFIC GRAVITY TEST

1. Size of sample - 5 kg of plus 3/8" aggregate.
2. Wash to remove dust - then dry at 110C temperature.
3. Immerse in 15 to 25C water for 24 hours and then weigh (B).
4. Determine weight of sample in water (C).
5. Dry again @ 110C temperature and weigh (A).
6. Bulk specific gravity $= \frac{A}{B - C}$
7. Apparent specific gravity $= \frac{A}{A - C}$

ABSORPTION TEST

1, 2, 3, 4, 5, and 6. Same as above.

7. Absorption percent (%) $= \frac{B - A \times 100}{A}$

TOUGHNESS TEST

1. Sample - Cylinder 25mm high and 25mm in diameter.
2. Steel plunger with spherical lower end resting on sample is subject to impact of a 2 kg, hammer. The energy of the blow is increased by increasing the height of fall of the hammer 1 cm after each blow.
3. The height of fall in centimeters at failure of the specimen is called toughness. H (in cm) = Toughness.

LOS ANGELES ABRASION TEST

BY LOS ANGELES MACHINE

1. Size sample - 5000 grams of clean, dry aggregate, properly graded (A)
2. Sample placed in machine which is then rotated for 500 revolutions @ 20 to 33 R.P.M.
3. Aggregate then removed and screened on a No. 12 sieve. Material retained on screen then washed, dried and weighed (B).
4. Percentage of wear $= \dfrac{A - B}{A}$

The lower the Los Angeles rating, the harder the rock

DEVAL ABRASION TEST

1. Sample - about 50 pieces broken by hand from a large piece of rock - wt. 5000 grams.
2. Sample placed in large cylinder mounted at an angle of 30 with the axis of rotation so that the rock charge is thrown from end to end twice during each of 10,000 revolutions.
3. Charge then screened over No. 12 sieve and the amount passing is expressed as a percentage of the initial weight and is called the percent of wear.
4. French coefficient of wear $= \dfrac{40}{\%\text{ of wear}}$

DORRY HARDNESS TEST

1. Sample - a cylindrical rock core 25mm in diameter from the rock specimen.
2. Sample is subjected to the abrasive action of quartz sand fed upon a revolving steel disk.
3. The end of the sample is worn away in inverse ratio to its hardness. The amount of loss is expressed in the form of a coefficient as follows.

Coefficient of hardness $= 20 - \dfrac{W}{3}$

W = loss of weight after 1000 R.P.M. of disk.

ABRASION INDEX

HIGHLY ABRASIVE

Manganese ore, Georgia	3.2949
Aluminum oxide, New York	1.4114
Sandstone, Pennsylvania	1.3121
Oxygen furnace slag, Ontario	1.0828
Chert, Missouri	0.9829
Stone and bauxite clinker, Indiana	0.9489
Gravel, Mississippi	0.8888
Stone, Virginia	0.7969
White quartz, Maine	0.7000

ABRASIVE - Wear can be minimized by design and materials of construction

Calcined alumina, Louisiana	0.6879
Open hearth pot slag, New York	0.6830
High-silica limestone, Pennsylvania	0.4838
Granite, Puerto Rico	0.4517
Feldspar, Virginia	0.3650
Burned brick and tile, Pennsylvania	0.3491
Sintered ore, Alabama	0.3065
Trap rock, Pennsylvania	0.3031
Mica-bearing stone, New York	0.2928
Feldspar, New Hampshire	0.2871
Tungsten ore, California	0.2253
Cement clinker, Pennsylvania	0.2206
Iron ore, Missouri	0.1992
Transvaal chrome ore, Ohio	0.1755
Coke breeze, Alabama	0.1690
Calcined bauxite, Missouri	0.1671
Red limestone, Vermont	0.1452
Scoria volcanic cinder, Texas	0.1352
Cement clinker, Quebec	0.1231
Grog, New Jersey	0.1052
Amorphous silica, Illinois	0.0978
Travertine, Australia	0.0838
Phosphate nodules, Tennessee	0.0813
Cement clinker, Kentucky	0.0695
Hematite, Venezuela	0.0620
Barite, Arkansas	0.0550
Limestone, Indiana	0.0526
Dolomitic clinker, Ohio	0.0494
Cement rock, Brazil	0.0444
Ferro-Phosphorus, Oklahoma	0.0443
Dolomite, West Virginia	0.0417

NON - ABRASIVE - For all practical purposes parts wear is not critical.

Shale, Virginia	0.0345
Antimony ore, New Jersey	0.0315
Oil Shale, Colorado	0.0270
Chamotte, Michigan	0.0250
Zinc sinter, Pennsylvania	0.0249
Limestone, Ohio	0.0241
Diabase rock, Virginia	0.0199
Extruded zircon, New Jersey	0.0186
Weathered shale, Virginia	0.0131
Zinc oxide, Pennsylvania	0.0078
Diatomaceous shale clinker, England	0.0078
Dolomite, Alabama	0.0062
Sandstone, California	0.0038
Red flux, Australia	0.0031

PADDLE ABRASION TEST

1. Sample - 1600 grams (56.4 oz.) of rock sized 3/4" x 1/2".

2. Paddle abrasion machine is a slowly rotating drum with synchronous rotating high speed steel paddle turning on the drum's axis. The slowly rotating drum is used to keep the material active.

Paddle is 500 Brinnel hardness, washed, dried and weighed before the sample is run. A new paddle is used for each test.

3. Four batches of 400 grams are run for 15 minutes each. Initial run is to work-harden the paddle.

4. After samples are run, paddle is washed, dried and re-weighed.

5. Grams of paddle weight loss indicate abrasiveness of rock. Refer to abrasiveness index chart on opposite page.

CHEMICAL ANALYSIS FOR SILICA EQUIVALENT

To Determine Suitability For Impact Crushers

1. Sample - 5 pounds of stone.

2. Sample is chemically analyzed for percentages of:

   * Calcium Carbonate
   * Silica
   * Metallic Oxides
   * Magnesium Carbonate

3. Silica Equivalent = $2(Al_2O_3 + \text{Total Fe}) + SiO_2 + MgO$

4. For primary impact crushers, silica equivalents under 0.15 are generally suitable.

   For secondary impact crushers, silica equivalents under 0.05 are generally suitable.

5. If more than 5% magnesium carbonate or other abrasive element is present, back-up tests such as paddle abrasion test should be performed.

GRADING FOR FINE AGGREGATE

Sieve (ASTM C-33 Specification Sand)	Percent Passing
9.51mm (3/8")	100
4.76mm (No. 4)	95 to 100
2.38mm (No. 8)	80 to 100
1.19mm (No. 16)	50 to 85
595 micron (No. 30)	25 to 60
297 micron (No. 50)	10 to 30
149 micron (No. 100)	2 to 10

QUARRY RUN SCREEN ANALYSIS

VANPORT LIMESTONE BLUE-GRAY STONE OF MEDIUM HARDNESS AND LOW TOUGHNESS

Size		% Passing	Individual % Retained	Size		% Passing	Individual % Retained
(In.)	(mm)			(In.)	(mm)		
36	914	100	10	24	609	100	6
24	609	90	34	18	457	94	20
12	305	56	14	12	305	74	18
8	203	42	8	8	203	56	10
6	152	34	9	6	152	46	12
4	102	25	7	4	102	34	6
3	76	18	7	3	76	28	10
2	51	11	3	2	51	18	5
1-1/2	38	8	3	1-1/2	38	13	5
1	25	5	2	1	25	8	3
3/4	19	3	3	3/4	19	5	2
				1/2	13	3	3

Size		% Passing	Individual % Retained	Size		% Passing.	Individu al % Retained
(In.)	(mm)			(In.)	(mm)		
20	508	100	5	18	457	100	10
16	406	95	11	12	305	90	22
12	305	84	21	8	203	68	12
8	203	63	11	6	152	56	14
6	152	52	13	4	102	42	8
4	102	39	7	3	76	34	10
3	76	32	10	2	51	24	6
2	51	22	7	1-1/2	38	18	7
1-1/2	38	15	5	1	25	11	3
1	25	10	3	3/4	19	8	3
3/4	19	7	3	1/2	13	5	2
1/2	13	4	4	3/8	10	3	3

QUARRY RUN SCREEN ANALYSIS
(Continued)

FINE GRAINED GRAY BIOTITE GRANITE 163 LBS./CU. FT. COMPRESSIVE STRENGTH 33,090 LBS./SQ. IN.

Size (In.)	Size (mm)	% Passing	Individual % Retained	Size (In.)	Size (mm)	% Passing	Individual % Retained
36	914	100	19	24	610	100	19
30	762	81	12	20	508	81	8
24	610	69	5	18	457	73	13
20	508	64	4	12	305	60	16
18	457	60	16	8	203	44	12
12	305	44	12	6	152	32	6
8	203	32	6	4	102	26	6
6	152	26	7	3	76	20	5
4	102	19	4	2	51	15	4
3	76	15	5	1-1/2	38	11	3
2	51	10	2	1	25	8	2
1-1/2	38	8	3	3/4	19	6	2
1	25	5	5	1/2	13	4	1
				3/8	10	3	3

Size (In.)	Size (mm)	% Passing	Individual % Retained	Size (In.)	Size (mm)	% Passing	Individual % Retained
20	508	100	21	18	457	100	31
18	457	79	13	12	305	69	14
12	305	66	16	8	203	55	11
8	203	50	10	6	152	44	12
6	152	40	11	4	102	32	6
4	102	29	5	3	76	26	5
3	76	24	7	2	51	21	6
2	51	17	4	1-1/2	38	15	5
1-1/2	38	13	4	1	25	10	2
1	25	9	2	3/4	19	8	3
3/4	19	7	2	1/2	13	5	1
1/2	13	5	2	3/8	10	4	1
3/8	10	3	1	1/4	6	3	3
1/4	6	2	2				

QUARRY RUN SCREEN ANALYSIS
(Continued)

STONE IS SHATTERED AND FILLED WITH MUD SEAMS TENDS TO BE SLABBY

Size (In.)	Size (mm)	% Passing	Individual % Retained	Size (In.)	Size (mm)	% Passing	Individual % Retained
36	914	100	21	24	610	100	21
30	762	79	18	20	508	79	9
24	610	61	11	18	457	70	25
20	508	50	5	12	305	45	17
18	457	45	16	8	203	28	7
12	305	29	11	6	152	21	9
8	203	18	6	4	102	12	4
6	152	12	5	3	76	8	3
4	102	7	2	2	51	5	1
3	76	5	1	1-1/2	38	4	1
2	51	4	1	1	25	3	3
1-1/2	38	3	1				
1	25	2	2				

Size (In.)	Size (mm)	% Passing	Individual % Retained	Size (In.)	Size (mm)	% Passing	Individual % Retained
20	508	100	14	18	457	100	38
18	457	89	31	12	305	62	22
12	305	55	20	8	203	40	11
8	203	35	10	6	152	29	11
6	152	25	9	4	102	18	6
4	102	16	6	3	76	12	5
3	76	10	4	2	51	7	2
2	51	6	1	1-1/2	38	5	1
1-1/2	38	5	1	1	25	4	1
1	25	4	1	3/4	19	3	1
3/4	19	3	1	1/2	13	2	2
1/2	13	2	2				

AGGREGATE SPECIFICATIONS

1. Lightweight Aggregates - Structural Concrete - ASTM Designation C330-53T
2. Concrete Aggregates - ASTM Designation C33-55T
3. Coarse Aggregate - Highway Construction - ASTM D448-54
4. Crushed Slag and Gravel - Bituminous Concrete Base and Surface Courses - ASTM Designation D692-54
5. Crushed SLAG AND Gravel - Waterbound Macadam Base and Surface Coarses - ASTM Designation D694-55

Total % Passing	(mm)	(In)	SPR No 1	SPR No 2	SPR No 24	SPR No 3	SPR No 357	SPR No 4	SPR No 467	SPR No 5	SPR No 56	SPR No 57
Screen Size (Square Opening)	102	4"	100									
	88	3-1/2"	90-100									
	76	3"	--	100	100							
	63	2-1/2"	25-60	90-100	90-100	100	100					
	51	2"	--	35-70	--	95-100	95-100	100	100			
	37	1-1/2"	0-15	0-15	25-60	35-70	--	90-100	95-100	100	100	100
	25	1"	--	--	--	0-15	35-70	20-55	--	90-100	90-100	95-100
	19	3/4"	0-5	0-5	0-10	--	--	0-15	35-70	20-55	40-75	--
	12	1/2"			0-5	0-5	10-30	--	--	0-10	15-35	25-60
	9	3/8"					--	0-5	10-30	0-5	0-15	--
	6	1/4"					--		--		--	--
		No. 4					0-5		0-5		0-5	0-10
		No. 8										0-5

Total % Passing	(mm)	(In)	SPR No 6	SPR No 67	SPR No 68	SPR No 7	SPR No 78	SPR No 8	SPR No 89	SPR No 9	SPR No 10	
Screen Size (Square Opening)	25	1"	100	100	100							
	19	3/4"	90-100	90-100	90-100	100	100					
	12	1/2"	20-55	--	--	90-100	90-100	100	100			
	9	3/8"	0-15	20-55	30-65	40-70	40-75	85-100	90-100	100	100	
	6	1/4"	--	--	--	--	--	--	--	--	--	
		No. 4	0-5	0-10	5-25	0-15	5-25	10-30	20-55	85-100	85-100	
		No. 8		0-5	0-10	0-5	0-10	0-10	5-30	10-40	--	
		No. 16			0-5		0-5	0-5	0-10	0-10	--	
		No. 50							0-5	0-5	--	
		No. 100									10-30	

SPR - Simplified Practice Recommendation

PIT RUN SCREEN ANALYSIS

Size (mm)	Size (in.)	PERCENT PASSING: WISCONSIN "BONEY"	NORTHERN ILLINOIS	NORTHERN ILLINOIS	TEXAS-EAGLE LAKE	MINNESOTA	NEW ENGLAND "BONEY"	NEW ENGLAND	FLORIDA CORAL ROCK	CENTRAL MICHIGAN SCALPED AT 1.5"	EAST CENTRAL MICHIGAN SCALPED AT 1.5"	CENTRAL INDIANA ABOVE WATER TABLE	CENTRAL INDIANA BELOW WATER TABLE	S.E. INDIANA	S.W. OHIO	WESTERN OHIO	SAN GABRIEL VALLEY	CORONA	SAN DIEGO
609	24"	100																	
508	20"	--						100											
305	12"	97					100	95											
203	8"	94				100	--	--											
152	6"	86				--	--	--	100								80	95	98
127	5"	78				--	--	--	--								--	--	--
102	4"	75				--	80	75	--								--	--	--
88	3.5"	73				--	--	--	75								--	--	--
76	3"	66				--	--	--	--							100	--	--	84
63	2.5"	65	100			--	--	--	--							96	--	--	--
51	2"	62	99		100	--	70	58	--			100		97	100	90	--	--	--
37	1.5"	58	--	100	99	--	65	--	62	100	100	88	100	92	83	76	65	90	65
25	1"	52	90	94	90	70	60	--	53	97	89	87	87	86	78	64	--	--	52
19	.75"	50	84	88	84	66	55	--	47	96	81	85	85	78	68	55	50	85	44
12	.50"	42	76	--	78	62	45	50	41	89	74	81	75	69	60	47	42	--	37
9	.375"	40	70	78	73	58	--	--	33	84	68	77	66	60	--	42	40	75	--
6	.25"	35	62	--	--	54	38	40	--	76	61	71	53	--	--	--	--	--	--
	4M	32	58	66	70	50	35	--	20	68	56	65	43	47	41	32	35	65	33
	8M	--	49	59	64	42	--	--	--	53	46	49	24	40	29	24	29	50	--
	16M	--	40	--	54	--	--	--	--	39	36	33	12	29	20	14	--	--	--
	20M	--	36	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	30M	--	29	--	41	--	--	--	--	27	27	22	6	19	13	8	--	--	--
	40M	--	15	19	--	--	--	--	--	--	--	--	--	11	--	--	--	--	--
	50M	--	--	--	15	--	--	--	--	11	14	13	2	5	3	3	--	--	--
	100M	--	--	--	2	--	--	--	--	3	4	4	1	3	2	1	--	8	--
	200M	--	--	4	--	--	--	--	--	3	2	2	--	1	1	--	--	--	--
	Decant	--	--	--	--	--	--	--	--	6	6	3	1	--	--	--	--	--	--

Note: The above pit run analyses are samples from specific locations. They do not represent "typical" sand and gravel analyses from an area. Final equipment selection must be based on screen analyses from the site of the source material.

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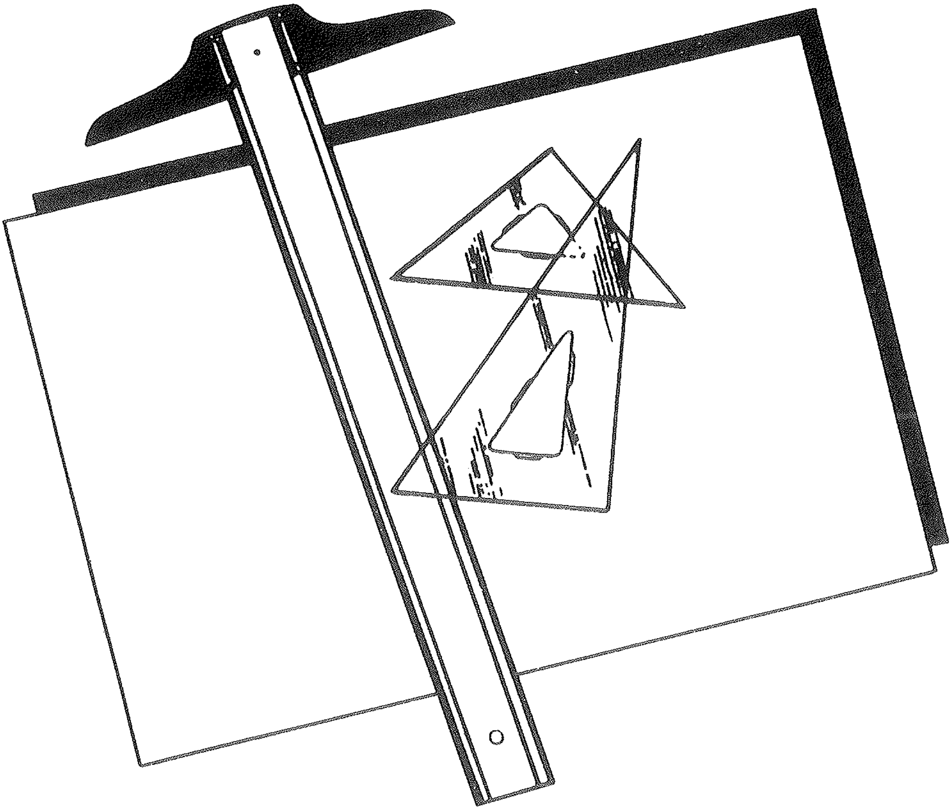
Engineering Facts



NEMA FRAME STANDARDS FOR SQUIRREL CAGE, DRIP PROOF

The motor ratings and dimensions listed on these pages are in accord with the National Electrical Manufactures Association Standards. NEMA has conducted several re-rating programs which have led to reductions in frame size requirements. "Old" (pre-1953) NEMA frames were replaced by "U" frames in the 1953 standard and in 1963 "T" frames were established.

NEMA Design B Motors account for 90% of the 3-phase motors sold and are the most widely stocked. They have low starting current, normal torque and normal slip and are suitable for most fan, blower, pump and machine tool applications of 15 HP and below.

NEMA Design C Motors are next in popularity having low starting current, high breakaway torque, and normal slip. They are available from limited stocks in 7-1/2 HP @ 1800 RPM and larger. They usually need not be specified below 15 HP. Desirable for "hard-to-start" applications such as plunger pumps, conveyors, and compressors.

NEMA Design D Motors are available on special order. They have high breakaway torque combined with high slip and are recommended for punch presses, shears and other high inertia machinery or multi-motor conveyor drives where motors operate in mechanical parallel.

The most popular motor-mounting style for industry is the rigid or foot mounting.

Motors with **NEMA C Face Mounting** (essentially a flat machined face with male pilot) use the suffix letter C; for example, 143 TC. They are popular for use with NEMA C-Face Speed Reducers. The mounting is available with or without the standard rigid base in all frames.

The following pages show various motors used in the crushing industry.

ELECTRIC MOTORS FOR USE WITH CRUSHERS

(60 hertz)

DESCRIPTION OF BASIC MOTOR

All motors NEMA standard, open drip proof or totally enclosed fan cooled, 1.15 service factor, normal starting torque, squirrel cage induction, continuous rated, 3 phase, 60 hertz, 230/480 volt.

		OPEN DRIP PROOF		TOTALLY ENCLOSED FAN COOLED	
HP	RPM	NEMA FRAME	WEIGHT	NEMA FRAME	WEIGHT
75	1200	405T	1000	405T	1270
100	1200 1800	444T 404T	1260 945	444T 405T	1730 1300
125	1200 1800	445T 405T	1375 1055	445T 444T	1880 1730
150	1200 1800	445TZ(1) 444T	1450 1235	447TZ(1) 445T	2090 1845
200	1200 1800	505UZ(1) 445T	2045 1400	505UZ(1,3) 447TZ(1)	2745 2115
250	1200 1800	505UZ(1) 447TZ(1)	2210 1630	N587UZ(1) 505UZ(1,3)	3790 2850
300	1200 1800	507UZ(1) 447TZ(1)	2575 1680	N587UZ(1) N587UZ(1)	4015 3850
350	1200 1800	N.A. 505US(1)	N.A. 2100	N.A. N587US(1,3)	N.A. 4005
400	1200 1800	N.A. 505US(1)	N.A. 2225	N.A. N.A.	N.A. N.A.

(1) 460 VOLT ONLY
(3) NEMA DESIGN A
N.A. Consult Factory

Note #1 - The electric motors are suitable for operation up to 3,300' elevation. Motors that operate over 3,300' above sea level consult motor manufacture.

ELECTRIC MOTORS FOR USE WITH CRUSHERS

(50 hertz)

DESCRIPTION OF BASIC MOTOR

All motors NEMA standard, open drip proof or totally enclosed fan cooled, 1.15 service factor, normal starting torque, squirrel cage induction, continuous rated, 3 phase, 50 hertz, 380 volt.

		OPEN DRIP PROOF		TOTALLY ENCLOSED FAN COOLED	
HP	RPM	NEMA FRAME	WEIGHT	NEMA FRAME	WEIGHT
75	1000	444T	1260	405T	1265
100	1000	445T	1375	445T	1880
	1500	405T	1055	444T	1725
125	1000	445TZ	1450	447TZ(3)	2090
	1500	444T	1235	445T	1845
150	1000	505UZ	2045	505UZ(3)	2745
	1500	445T	1400	447TZ(5)	2115
200	1000	505UZ	2205	N578UZ	3790
	1500	447TZ	1630	505UZ(3)	2850
250	1000	507UZ	2575	N587UZ(5)	4015
	1500	447TZ	1680	N587UZ	3850
300	1000	N.A.	N.A.	N.A.	N.A.
	1500	505US	2100	N587US(3)	4005
350	1000	N.A.	N.A.	N.A.	N.A.
	1500	505US	2225	N.A.	N.A.
400	1000	N.A.	N.A.	N.A.	N.A.
	1500	N.A.	N.A.	N.A.	N.A.

(3) NEMA DESIGN A
(5) 1.0 SERVICE FACTOR
N.A. Consult Factory

Note #2 - The electric motors are suitable for operation up to 3,300' elevation. Motors that operate over 3,300' above sea level consult motor manufacture.

ELECTRIC MOTORS FOR USE WITH SCREENS
(60 hertz)

DESCRIPTION OF BASIC MOTOR

All motors NEMA standard, totally enclosed fan cooled, 1.15 service factor, squirrel cage induction, constant speed, full voltage starting, 3 phase, 60 hertz, 230/480 volt, 1800 RPM.

HP	WEIGHT	NEMA DESIGN "B" NORMAL STARTING TORQUE	NEMA DESIGN "C" HIGH STARTING TORQUE
		NEMA FRAME	NEMA FRAME
7.5	150	213T	213T
10	165	215T	215T
15	230	254T	254T
20	280	256T	256T
25	365	284T	284T
30	395	286T	286T
40	560	324T	324T
50	585	326T	326T
60	725	364T	364T

Note #1 - The electric motors are suitable for operation up to 3,300' elevation. Motors that operate over 3,300' above sea level consult motor manufacture.

ELECTRIC MOTORS FOR USE WITH SCREENS
(50 hertz)

DESCRIPTION OF BASIC MOTOR

All motors NEMA standard, totally enclosed fan cooled, 1.15 service factor, squirrel cage induction, constant speed, full voltage starting, 3 phase, 50 hertz, 380 volt, 1500 RPM.

HP	WEIGHT	NEMA DESIGN "B" NORMAL STARTING TORQUE	NEMA DESIGN "C" HIGH STARTING TORQUE
		NEMA FRAME	NEMA FRAME
7.5	150	213T	213T
10	165	215T	215T
15	230	254T	254T
20	280	256T	256T
25	365	286T	286T
30	395	286T	286T
40	560	324T	324T
50	585	326T	326T
60	725	364T	364T

Note #1 - The electric motors are suitable for operation up to 3,300' elevation. Motors that operate over 3,300' above sea level consult motor manufacture.

ELECTRIC MOTORS
FOR USE WITH VIBRATING SCREENS
(60 hertz)

DESCRIPTION OF BASIC MOTOR

All motors NEMA B, open drip proof or totally enclosed fan cooled, 1.15 service factor, normal starting torque, squirrel cage induction, constant speed, full voltage starting, 3 phase, 60 hertz, 230/480 volt.

		OPEN DRIP PROOF		TOTALLY ENCLOSED FAN COOLED	
HP	RPM	NEMA FRAME	WEIGHT	NEMA FRAME	WEIGHT
3	1200	213T	120	213T	125
5	1200	215T	135	215T	150
7.5	1200	254T	210	254T	220
10	1200	256T	235	256T	245
15	1200	284T	325	284T	370
20	1200	286T	355	286T	400
25	1200	324T	430	324T	485
30	1200	326T	470	326T	530
40	1200	364T	595	364T	700
50	1200	365T	640	365T	780
60	1200	404T	920	404T	1120
75	1200	405T	1000	405T	1270
100	1200	444T	1260	444T	1730

Note #1 - The electric motors are suitable for operation up to 3,300' elevation. Motors that operate over 3,300' above sea level consult motor manufacture.

ELECTRIC MOTORS FOR USE WITH VIBRATING FEEDERS

(50 hertz)

DESCRIPTION OF BASIC MOTOR

All motors NEMA B, open drip proof or totally enclosed fan cooled, 1.15 service factor, normal starting torque, squirrel cage induction, constant speed, full voltage starting, 3 phase, 50 hertz, 380 volt.

		OPEN DRIP PROOF		TOTALLY ENCLOSED FAN COOLED	
HP	RPM	NEMA FRAME	WEIGHT	NEMA FRAME	WEIGHT
3	1000	213T	120	213T	125
5	1000	444T	135	115T[1]	150
7.5	1000	215T[1]	210	254T	220
10	1000	254T	235	256T	245
15	1000	284T	325	284T	375
20	1000	286T	360	286T	405
25	1000	324T	440	324T	495
30	1000	326T	480	326T	540
40	1000	364T	605	364T	715
50	1000	365T	650	365T	795
60	1000	404T	935	404T	1145
75	1000	405T	1000	405T	1295
100	1000	444T	1285	444T	1765

[1] 1.0 SERVICE FACTOR, 1.15 S.F. NOT AVAILABLE

Note #1 - The electric motors are suitable for operation up to 3,300' elevation. Motors that operate over 3,300' above sea level please consult motor manufacture.

ELECTRICAL INFORMATION

Electrical Formulas

To Find	Alternating Current	
	Single-Phase	Three-Phase
Amperes when horsepower is known	$\frac{Hp \times 746}{E \times Eff \times pf}$	$\frac{Hp \times 746}{1.73 \times E \times Eff \times pf}$
Amperes when kilowatts are known	$\frac{Kw \times 1000}{E \times pf}$	$\frac{Kw \times 1000}{1.73 \times E \times pf}$
Amperes when Kva are known	$\frac{Kva \times 1000}{E}$	$\frac{Kva \times 1000}{1.73 \times E}$
Kilowatts	$\frac{I \times E \times pf}{1000}$	$\frac{1.73 \times I \times E \times pf}{1000}$
Kva	$\frac{I \times E}{1000}$	$\frac{1.73 \times I \times E}{1000}$
Horsepower = (Output)	$\frac{I \times E \times Eff \times pf}{746}$	$\frac{1.73 \times I \times E \times Eff \times pf}{746}$

I = Amperes; E = Volts; Eff = Efficiency; pf = Power Factor; Kva = Kilovolt amperes; Kw = Kilowatts; R = Ohms.

To Find	Alternating or Direct Current
Amperes when voltage and resistance is known	E/R
Voltage when resistance and current are known	IR
Resistance when voltage and current are known	E/I

General Information (Approximation)

All Values At 100% Load:
- At 1800 rpm, a motor develops 36 lb.-in. per hp
- At 1200 rpm, a motor develops 54 lb.-in. per hp
- At 575 volts, a 3-phase motor draws 1 amp per hp
- At 460 volts, a 3-phase motor draws 1.25 amp per hp
- At 230 volts, a 3-phase motor draws 2.5 amp per hp
- At 230 volts, a single-phase motor draws 5 amp per hp
- At 115 volts, a single-phase motor draws 10 amp per hp

COMPARISON OF METHODS OF STARTING SQUIRREL CAGE INDUCTION MOTORS

Starter Type	% Full-Voltage Value			Starter Type	% Full-Voltage Value		
	Voltage at Motor	Line Current	Motor Output Torque		Voltage at Motor	Line Current	Motor Output Torque
Full Voltage	100	100	100	Primary-resistor			
Autotransformer				Typical rating	80	80	64
80 pc tap	80	64*	64	Part-winding			
65 pc tap	65	42*	42	Low-speed motors			
50 pc tap	50	25*	25	(1/2-1/2)	100	50	50
Primary-reactor				High-speed motors			
80 pc tap	80	80	64	(1/2-1/2)	100	70	50
65 pc tap	65	65	42	High-speed motors			
50 pc tap	50	50	25	(2/3-1/3)	100	65	42
				Wye Start-Delta Run (1/3-1/3)	100	33	33

*Autotransformer magnetizing current not included. Magnetizing current usually less than 25 percent motor full-load current.

ELECTRICAL INFORMATION
(continued)

NEMA Electrical Enclosure Types

Type	Description
NEMA Type 1 (General Purposes)	For indoor use wherever oil, dust or water is not a problem.
NEMA Type 2 (Driptight)	Used indoors to exclude falling moisture and dirt.
NEMA Type 3 (Weatherproof)	Provides protection against rain, sleet and snow.
NEMA Type 4 (Watertight)*	Needed when subject to great amounts of water from any angle - such as areas which are repeatedly hosed down.
NEMA Type 5 Dust Tight (Nonhazardous)	Used for excluding dust. (All NEMA 12 and JIC enclosures are usually suitable for NEMA 5 use).
NEMA Type 9 Dust Tight (Hazardous)**	For locations where combustible dusts are present.
NEMA Type 12 (Industrial Use)	Used for excluding oil, coolant, flying dust, lint, etc.

NOTE: Joint Industry Conference (JIC) enclosures are similar in design to NEMA 12's. For more complete details see NEMA or JIC Standards for enclosures.

*Not designed to be submerged.

**Class II Groups E, F and G.

Engineering Formulas and Constants**

1 HP = 33,000 foot-pounds of work per minute.
1 HP = .746 K.W. = K.W./1.341.
1 HP = 2547 B.T.U. per hour.
1 B.T.U. = heat required to raise 1 lb. water 1°F.
1 B.T.U. = 777.6 foot-pounds work.
1 Kilowatt Hour = 3415 B.T.U.
Heat Value of Carbon = 14,600 B.T.U. per pound.
Latent Heat of Fusion of Ice = 143.15 B.T.U. per pound.
Latent Heat of Evaporation of Water at 212°F. = 970.4 B.T.U. per pound.
Total Heat of Saturated Stream at Atmospheric Pressure = 1,150.4 B.T.U. per pound.
1 Ton of Refrigeration = 288,000 B.T.U. per 24 hours.
g = Acceleration of Gravity (commonly taken as 32.16 feet per second).
1 Radian = 57.296 degrees.
1 Meter = 100 cm. = 39.37 inches.
1 Kilometer = .62137 miles.
1 Gallon = 231 cubic inches.
1 Barrel = 31.5 gallons.
Atmospheric Pressure = 14.7 pounds per sq. in. = 29.92 inches of mercury at 32°F.
1 Lb. per Sq. In. Pressure = 2.3095 feet fresh water at 62°F. = 2.0355 inches mercury at 32°F. = 2.0416 inches mercury at 62°F.
Water Pressure (lbs. per sq. in.) = .433 x height of water in feet (fresh water at 62°F.).
Weight of 1 cu. ft. Fresh Water = 62.355 lbs. at 62°F. = 59.76 lbs. at 212°F.
Weight of 1 cu. ft. Air at 14.7 lbs. per sq. in. Pressure = .07608 lbs. at 62°F = .08073 lbs. at 32°F.

ELECTRIC MOTOR "AVERAGE" AMPERE RATINGS

The full load currents shown below are "average values" for horsepower rated motors of several manufactures at the more common rated voltages and speeds. These "average values" should be used only as a guide.

3 Phase, 60 Hertz AC Induction Motors

HP	RPM	Full Load Current					
		200 v	230 v	460 v	575 v	2200 v	4000 v
1/4	1800	1.10	0.96	0.48	0.38	--	--
	1200	1.33	1.16	0.58	0.46	--	--
	900	1.67	1.45	0.73	0.58	--	--
1/3	1800	1.33	1.16	0.58	0.47	--	--
	1200	1.64	1.43	0.72	0.58	--	--
	900	2.01	1.75	0.88	0.71	--	--
1/2	1800	1.93	1.68	0.84	0.67	--	--
	1200	2.38	2.07	1.04	0.83	--	--
	900	3.34	2.90	1.45	1.16	--	--
3/4	1800	2.68	2.33	1.17	0.93	--	--
	1200	3.28	2.85	1.43	1.14	--	--
	900	3.97	3.45	1.73	1.38	--	--
1	3600	3.16	2.75	1.38	1.10	--	--
	1800	3.51	3.05	1.53	1.22	--	--
	1200	4.07	3.54	1.77	1.42	--	--
	900	4.30	3.74	1.87	1.50	--	--
1-1/2	3600	4.80	4.17	2.09	1.67	--	--
	1800	4.92	4.28	2.14	1.71	--	--
	1200	5.58	4.85	2.43	1.94	--	--
	900	6.68	5.81	2.91	2.32	--	--
2	3600	6.39	5.56	2.78	2.22	--	--
	1800	6.62	5.76	2.88	2.30	--	--
	1200	7.30	6.35	3.18	2.54	--	--
	900	8.29	7.21	3.61	2.88	--	--
3	3600	9.05	7.87	3.94	3.14	--	--
	1800	9.53	8.29	4.14	3.32	--	--
	1200	10.30	8.92	4.46	3.56	--	--
	900	11.70	10.20	5.09	4.08	--	--
5	3600	14.60	12.70	6.34	5.08	--	--
	1800	15.20	13.20	6.60	5.28	--	--
	1200	16.20	14.10	7.05	5.64	--	--
	900	17.90	15.60	7.80	6.24	--	--
7-1/2	3600	22.10	19.20	9.60	7.68	--	--
	1800	22.20	19.30	9.70	7.72	--	--
	1200	23.30	20.30	10.20	8.12	--	--
	900	27.40	23.80	11.90	9.51	--	--

AVERAGE AMPERE RATINGS

3 Phase, 60 Hertz AC Induction Motors
(continued)

HP	RPM	Full Load Current					
		200 v	230 v	460 v	575 v	2200 v	4000 v
10	3600	28.20	24.50	12.30	9.80	--	--
	1800	29.00	25.20	12.60	10.10	--	--
	1200	30.60	26.60	13.30	10.60	--	--
	900	33.20	28.90	14.50	11.60	--	--
	600	38.90	33.80	16.90	13.50	--	--
15	3600	42.20	36.70	18.40	14.70	--	--
	1800	43.80	38.10	19.10	15.20	--	--
	1200	45.90	39.90	20.00	16.00	--	--
	900	48.20	41.90	21.00	16.80	--	--
	600	55.50	48.30	24.20	19.30	--	--
20	3600	56.40	49.00	24.50	19.60	5.20	2.90
	1800	58.10	50.50	25.30	20.20	5.30	3.00
	1200	59.50	51.70	25.90	20.60	5.40	3.10
	900	62.80	54.60	27.30	21.80	5.80	3.20
	600	70.70	61.50	30.80	24.60	6.40	3.50
25	3600	68.10	59.20	29.60	23.60	6.30	3.40
	1800	72.10	62.70	31.30	25.00	6.50	3.60
	1200	74.10	64.70	32.30	25.80	6.70	3.70
	900	77.50	67.40	33.70	27.00	6.90	3.80
	600	82.70	71.90	35.90	28.80	8.10	4.40
30	1800	83.70	72.80	36.40	29.20	7.80	4.30
	1200	88.70	77.10	38.60	30.80	8.00	4.40
	900	91.30	79.40	39.70	31.80	8.20	4.50
	600	101.10	87.90	43.90	35.20	9.30	5.00
40	1800	112.70	98.00	49.00	39.20	10.00	5.50
	1200	113.90	99.00	49.50	39.60	10.30	5.70
	900	119.60	104.00	52.00	41.60	10.60	5.80
	600	130.00	113.00	56.50	45.20	11.50	6.30
50	1800	139.20	121.00	60.50	48.40	12.30	6.80
	1200	140.30	122.00	61.00	48.80	12.40	6.80
	900	146.10	127.00	63.50	50.80	13.10	7.20
	600	158.70	138.00	69.00	55.20	14.20	7.80
60	1800	164.50	143.00	71.50	57.20	14.60	8.00
	1200	170.20	148.00	74.00	59.20	14.90	8.20
	900	173.70	151.00	75.50	60.40	15.40	8.50
	600	186.30	162.00	81.00	64.80	16.70	9.20

AVERAGE AMPERE RATINGS
3 Phase, 60 Hertz AC Induction Motors
(continued)

HP	RPM	Full Load Current					
		200 v	230 v	460 v	575 v	2200 v	4000 v
75	1800	204.70	178.00	89.00	71.20	18.00	9.90
	1200	208.20	181.00	90.50	72.40	18.20	10.00
	900	215.10	187.00	93.50	74.80	19.00	10.50
	600	228.90	199.00	99.50	79.60	21.00	11.60
100	1800	268.00	233.00	116.00	93.20	23.60	13.00
	1200	274.90	239.00	120.00	95.60	24.20	13.30
	900	281.80	245.00	123.00	98.00	24.80	13.60
	600	295.60	257.00	128.00	103.00	26.40	14.50
	450	333.50	290.00	145.00	116.00	29.80	16.40
125	1800	332.40	289.00	144.00	115.00	29.20	16.10
	1200	342.70	298.00	149.00	119.00	29.90	16.40
	900	350.80	305.00	153.00	122.00	30.90	17.00
	720	361.10	314.00	157.00	126.00	31.30	17.20
	600	368.00	320.00	160.00	128.00	32.80	18.00
	450	403.70	351.00	175.00	140.00	36.00	19.80
150	1800	397.90	346.00	173.00	138.00	34.80	19.10
	1200	402.50	350.00	175.00	140.00	35.50	19.50
	900	417.50	363.00	182.00	145.00	37.00	20.40
	720	432.40	376.00	188.00	150.00	37.00	20.40
	600	434.70	378.00	189.00	151.00	38.80	21.30
	450	480.70	418.00	209.00	166.00	42.00	23.10
200	1800	529.00	460.00	230.00	184.00	46.70	25.70
	1200	535.90	466.00	233.00	186.00	47.00	25.90
	900	563.50	490.00	245.00	196.00	49.40	27.20
	720	568.10	494.00	247.00	197.00	49.00	27.00
	600	572.70	498.00	249.00	199.00	50.90	28.00
	450	607.20	528.00	264.00	211.00	53.70	29.50
250	1800	657.80	572.00	286.00	229.00	57.50	31.60
	1200	667.00	580.00	290.00	232.00	58.50	32.20
	900	694.60	604.00	302.00	242.00	61.50	33.80
	720	718.80	625.00	312.00	250.00	61.50	33.80
	600	724.50	630.00	315.00	252.00	61.00	33.60
	450	724.50	630.00	315.00	252.00	65.30	35.90
	360	777.40	676.00	338.00	270.00	70.00	38.50
300	1800	787.80	685.00	342.00	274.00	69.00	38.00
	1200	800.40	696.00	348.00	278.00	70.00	38.50
	900	830.30	722.00	361.00	289.00	73.50	40.40
	600	830.30	722.00	361.00	289.00	72.30	39.80
	450	874.00	760.00	380.00	304.00	76.00	41.80
	360	954.50	830.00	415.00	332.00	82.80	45.50

* Centrifugal force causes this tensile load at each and every section of the rim. Hence, on rims split into two or more sections, the fastening at each joint should be designed to take the full load as calculated from the formula here given.

FORMULAS FOR ENTIRE FLYWHEEL

Kinetic energy of rotation of a flywheel (foot pounds) = .0001705 N^2 (WR^2).*

Torque to accelerate or decelerate a flywheel uniformly (pound inches).

$$= \frac{.03908\,(N_2 - N_1)\,(WR^2)\,*}{t}$$

where N_2 = final R.P.M. and N_1 = initial R.P.M.

Velocity at outside diameter (feet per minute) = 0.2618 ND.

W = weight (pounds).

R = radius of gyration (feet).

N = speed (R.P.M.).

t = time to change from N_1 to N_2 (seconds).

F = face of rim (inches).

D = outside diameter of rim (inches).

d = inside diameter of rim (inches).

K = weight per cubic inch of material (pounds).

*WR^2 = flywheel effect (pounds x feet^2). See table below for WR^2 of rims. Ordinarily the WR^2 of the rim only is considered, in unusual instances the relatively small WR^2 values of the hub and arms or web can be added directly to the WR^2 of the rim if desired. To find the WR^2 of a hub or web, use the WR^2 formula for rims, substituting the hub or web outside diameter, inside diameter, and width for D, d and F respectively. When arms are used instead of a web, an approximate WR^2 value of the arms is the total weight of the arms in pounds times the square of the radius in feet from the shaft center line to the mid point of the arms between hub and rim.

CENTRIFUGAL FORCE

R = Distance from the axis of rotation to the center of gravity of the body (feet).

N = Revolutions per minute.

v = Velocity of the center of gravity of the body (feet per second).

g = Acceleration due to gravity (32.16 commonly).

$$F = \frac{Wv^2}{gR} = \frac{WRN^2}{2933} = .000341\ WRN^2$$

F = Centrifugal force tending to move the body outward from the axis of rotation (pounds).

W = Weight of body (pounds).

FLYWHEEL FORMULAS

FORMULAS FOR FLYWHEEL RIMS

Property	Cast Iron Rim (Based On .26 Lbs. Per Cu. In.)	Steel Rim (Based On .283 Lbs. Per Cu. In.)	Rim of any material Weighing K Pounds Per Cubic Inch
Volume (Cubic Inches)	$.7854F(D^2-d^2)$	$.7854F(D^2-d^2)$	$.7854F(D^2-d^2)$
W Weight (Pounds)	$.2042F(D^2-d^2)$	$.2223F\ (D^2-d^2)$	$.7854FK(D^2-d^2)$
R Radius of Gyration (Feet)	$\sqrt{\frac{.8681(D^2+d^2)}{1000}}$	$\sqrt{\frac{.8681(D^2+d^2)}{1000}}$	$\sqrt{\frac{.8681(D^2+d^2)}{1000}}$
WR^2 Wt. X Sq. of Radius of Gyration (Lbs. x Ft.^{2})	$\frac{.1773F(D^4-d^4)}{1000}$	$\frac{.1929F(D^4-d^4)}{1000}$	$\frac{6818FK(D^4-d^4)}{1000}$
TA Tensile Load In Rim (Lbs.)	$\frac{.3078FN^2(D^3-d^3)}{1,000,000}$	$\frac{.3350FN^2(D^3-d^3)}{1,000,000}$	$\frac{1.184KFN^2(D^3-d^3)}{1,000,000}$

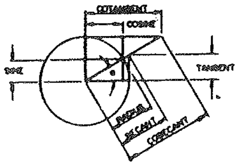
AREAS AND CIRCUMFERENCES OF CIRCLES

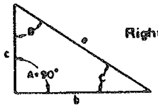
Dia.	Area	Cir.	Dia.	Area	Cir.	Dia.	Area	Cir.	Dia.	Area	Cir.
1/8	0.0123	0.3926	10	78.54	31.41	30	706.86	94.24	65	3318.3	204.2
1/4	0.0491	0.7854	10-1/2	86.59	32.98	31	754.76	97.38	66	3421.2	207.3
3/8	0.1104	1.178	11	95.03	34.55	32	804.24	100.5	67	3525.6	210.4
1/2	0.1963	1.570	11-1/2	103.86	36.12	33	855.30	103.6	68	3631.6	213.6
5/8	0.3067	1.963	12	113.09	37.69	34	907.92	106.8	69	3739.2	216.7
3/4	0.4417	2.356	12-1/2	112.70	39.27	35	962.11	109.9	70	3848.4	219.9
7/8	0.6013	2.748	13	132.73	40.84	36	1017.8	113.0	71	3959.2	223.0
1	0.7854	3.141	13-1/2	143.13	42.41	37	1075.2	116.2	72	4071.5	226.1
1-1/8	0.9940	3.534	14	153.93	43.98	38	1134.1	119.3	73	4185.3	229.3
1-1/4	1.2270	3.927	14-1/2	165.13	45.55	39	1194.5	122.5	74	4300.8	232.4
1-3/8	1.4840	4.319	15	176.71	47.12	40	1256.6	125.6	75	4417.8	235.6
1-1/2	1.7670	4.712	15-1/2	188.69	48.69	41	1320.2	128.8	76	4536.4	238.7
1-5/8	2.0730	5.105	16	201.06	50.26	42	1385.4	131.9	77	4656.0	241.9
1-3/4	2.4050	5.497	16-1/2	213.82	51.83	43	1452.2	135.0	78	4778.3	245.0
1-7/8	2.7610	5.890	17	226.98	53.40	44	1520.5	138.2	79	4901.6	248.1
2	3.1410	6.283	17-1/2	240.52	54.97	45	1590.4	141.3	80	5026.5	251.3
2-1/4	3.9760	7.068	18	254.46	56.54	46	1661.9	144.5	81	5153.0	254.4
2-1/2	4.9080	7.854	18-1/2	268.80	58.11	47	1734.9	147.6	82	5281.0	257.6
2-3/4	5.9390	8.639	19	283.52	59.69	48	1809.5	150.7	83	5410.6	260.7
3	7.0680	9.424	19-1/2	298.64	61.26	49	1885.7	153.9	84	5541.7	263.8
3-1/4	8.2950	10.21	20	314.16	62.83	50	1963.5	157.0	85	5674.5	267.0
3-1/2	9.6210	10.99	20-1/2	330.06	64.40	51	2042.8	160.2	86	5808.8	270.1
3-3/4	11.044	11.78	21	346.36	65.97	52	2123.7	163.3	87	5944.6	273.3
4	12.566	12.56	21-1/2	363.05	67.54	53	2206.1	166.5	88	6082.1	276.4
4-1/2	15.904	14.13	22	380.13	69.11	54	2290.2	169.6	89	6221.1	279.6
5	19.635	15.70	22-1/2	397.60	70.68	55	2375.8	172.7	90	6361.7	282.7
5-1/2	23.758	17.27	23	415.47	72.25	56	2463.0	175.9	91	6503.8	285.8
6	28.274	18.84	23-1/2	433.73	73.82	57	2551.7	179.0	92	6647.6	289.0
6-1/2	33.183	20.42	24	452.39	75.39	58	2642.0	182.2	93	6792.9	292.1
7	38.484	21.99	24-1/2	471.43	76.96	59	2733.9	185.3	94	6939.7	295.3
7-1/2	44.178	23.56	25	490.87	78.54	60	2872.4	188.4	95	7088.2	298.4
8	50.265	25.13	26	530.93	81.68	61	2922.4	191.6	96	7238.2	301.5
8-1/2	56.745	26.70	27	572.55	84.82	62	3019.0	194.7	97	7389.8	304.7
9	63.617	28.27	28	615.75	87.96	63	3117.2	197.9	98	7542.9	307.8
9-1/2	70.882	29.84	29	660.52	91.10	64	3216.9	201.0	99	7697.7	311.0

FUNCTIONS OF ANGLES

Angle	Sin	Cos	Tan	Angle	Sin	Cos	Tan
0	0.000	1.000	0.000	46	0.719	0.695	1.04
1	0.017	0.999	0.017	47	0.731	0.682	1.07
2	0.035	0.999	0.035	48	0.743	0.699	1.11
3	0.052	0.999	0.052	49	0.755	0.656	1.15
4	0.070	0.998	0.070	50	0.766	0.643	1.19
5	0.087	0.996	0.087				
6	0.105	0.995	0.105	51	0.777	0.629	1.23
7	0.112	0.993	0.123	52	0.788	0.616	1.28
8	0.139	0.990	0.141	53	0.799	0.602	1.33
9	0.156	0.988	0.158	54	0.809	0.588	1.38
10	0.174	0.985	0.176	55	0.819	0.574	1.43
11	0.191	0.982	0.194	56	0.829	0.559	1.48
12	0.208	0.978	0.213	57	0.839	0.545	1.54
13	0.225	0.974	0.231	58	0.848	0.530	1.60
14	0.242	0.970	0.249	59	0.857	0.515	1.66
15	0.259	0.966	0.268	60	0.866	0.500	1.73
16	0.276	0.961	0.287	61	0.875	0.485	1.80
17	0.292	0.956	0.306	62	0.883	0.469	1.88
18	0.309	0.951	0.325	63	0.891	0.454	1.96
19	0.326	0.946	0.344	64	0.898	0.438	2.05
20	0.342	0.940	0.364	65	0.906	0.423	2.14
21	0.358	0.934	0.384	66	0.914	0.407	2.25
22	0.375	0.927	0.404	67	0.921	0.391	2.36
23	0.391	0.921	0.424	68	0.927	0.375	2.48
24	0.407	0.914	0.445	69	0.934	0.358	2.61
25	0.423	0.906	0.466	70	0.940	0.342	2.75
26	0.438	0.898	0.488	71	0.946	0.326	2.90
27	0.454	0.891	0.510	72	0.951	0.309	3.08
28	0.469	0.883	0.532	73	0.956	0.292	3.27
29	0.485	0.875	0.554	74	0.961	0.276	3.49
30	0.500	0.866	0.577	75	0.966	0.259	3.73
31	0.515	0.857	0.601	76	0.970	0.242	4.01
32	0.530	0.848	0.625	77	0.974	0.225	4.33
33	0.545	0.839	0.649	78	0.978	0.208	4.70
34	0.559	0.829	0.675	79	0.982	0.191	5.14
35	0.574	0.819	0.700	80	0.985	0.174	5.67
36	0.588	0.809	0.727	81	0.988	0.156	6.31
37	0.602	0.799	0.754	82	0.990	0.139	7.12
38	0.616	0.788	0.781	83	0.993	0.122	8.14
39	0.629	0.777	0.810	84	0.995	0.105	9.51
40	0.643	0.766	0.839	85	0.996	0.087	11.43
41	0.656	0.755	0.869	86	0.998	0.070	14.30
42	0.679	0.743	0.900	87	0.999	0.052	19.08
43	0.682	0.731	0.933	88	0.999	0.035	28.64
44	0.695	0.719	0.966	89	0.999	0.017	57.28
45	0.707	0.707	1.000	90	1.000	1.000	Infinity

TRIGONOMETRIC FORMULAE





Right Angle Triangle

Formulas for Finding Functions of Angles

$\frac{\text{Side opposite}}{\text{Hypotenuse}}$	= Sine
$\frac{\text{Side adjacent}}{\text{Hypotenuse}}$	= Cosine
$\frac{\text{Side opposite}}{\text{Side adjacent}}$	= Tangent
$\frac{\text{Side adjacent}}{\text{Side opposite}}$	= Cotangent
$\frac{\text{Hypotenuse}}{\text{Side adjacent}}$	= Secant
$\frac{\text{Hypotenuse}}{\text{Side opposite}}$	= Cosecant

Formulas for Finding Sides of Right Angle Triangles with an Angle and Side Known

To Find: Length of side opposite	Hypotenuse x Sine Hypotenuse ÷ Cosecant Side adjacent x Tangent Side adjacent ÷ Cotangent
To Find: Length of side adjacent	Hypotenuse x Cosine Hypotenuse ÷ Secant Side opposite x Cotangent Side opposite ÷ Tangent
To Find: Length of Hypotenuse	Side opposite x Cosecant Side opposite ÷ Sine Side adjacent x Secant Side adjacent ÷ Cosine

To Find Angles and Sides of Right Angle Triangles

To Find Angles

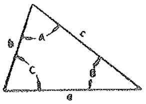
To Find:	Formulas
C	$\frac{c}{a}$ = Sine C
C	$\frac{b}{a}$ = Cosine C
C	$\frac{c}{b}$ = Tan. C
C	$\frac{b}{c}$ = Cotan. C
C	$\frac{a}{b}$ = Secant C
C	$\frac{a}{c}$ = Cosec. C
B	$\frac{b}{a}$ = Sine B
B	$\frac{c}{a}$ = Cosine B
B	$\frac{b}{c}$ = Tan. B
B	$\frac{c}{b}$ = Cotan. B
B	$\frac{a}{c}$ = Secant B
B	$\frac{a}{b}$ = Cosec. B

To Find Sides

To Find:	Formulas	
a	$\sqrt{b^2 + c^2}$	–
a	c x Cosec. C	$\frac{c}{\text{Sine C}}$
a	c x Secant B	$\frac{c}{\text{Cosine B}}$
a	b x Cosec. B	$\frac{b}{\text{Sine B}}$
a	b x Secant C	$\frac{b}{\text{Cosine C}}$
b	$\sqrt{a^2 - c^2}$	–
b	a x Sine B	$\frac{a}{\text{Cosecant B}}$
b	a x Cos. C	$\frac{a}{\text{Secant C}}$
b	c x Tan. B	$\frac{c}{\text{Cotangent B}}$
b	c x Cot. C	$\frac{c}{\text{Tangent C}}$
c	$\sqrt{a^2 - b^2}$	–
c	a x Cos. B	$\frac{a}{\text{Secant B}}$
c	a x Sine C	$\frac{a}{\text{Cosecant C}}$
c	b x Cot. B	$\frac{b}{\text{Tangent B}}$
c	b x Tan. C	$\frac{b}{\text{Cotangent C}}$

To Find Angles and Sides of Oblique Angle Triangles

Oblique Angle Triangle



To Find:	Known	Formulas	To Find:	Known	Formulas
C	A,B	$180^\circ - (A + B)$	A	B,C	$180^\circ - (B + C)$
b	a,B,A	$\frac{a \times \text{Sin. B}}{\text{Sin. A}}$	Cos. A	a,b,c	$\frac{b^2 + c^2 - a^2}{2bc}$
c	a,A,C	$\frac{a \times \text{Sin. C}}{\text{Sin. A}}$	Sin. C	c,A,a	$\frac{c \times \text{Sin. A}}{a}$
Tan. A	a,C,b	$\frac{a \times \text{Sin. C}}{b - (a \times \text{Cos. C})}$	Cot. B	a,C,b	$\frac{a \times \text{Cosec. C}}{b} - \text{Cot. C}$
B	A,C	$180^\circ - (A + C)$	c	b,C,B	b x Sin. C x Cosec. B
Sin. B	b,A,a	$\frac{b \times \text{Sin. A}}{a}$	–	–	–

ENGLISH STANDARD MEASURES

Long Measure

1 mile = 1760 yards = 5280 feet.
1 yard = 3 feet = 36 inches.
1 foot = 12 inches.

Surveyor's Measure

1 mile = 8 furlongs = 80 chains.
1 furlong - 10 chains = 220 yards.
1 chain = 4 rods = 22 yards = 66 feet = 100 links.
1 link = 7.92 inches.

Square Measure

1 Square mile = 640 acres = 6400 square chains.
1 acre = 10 square chains = 4840 square yards = 43,560 square feet.
1 square chain = 16 square rods = 484 square yards = 4356 square feet.
1 square yard = 9 square feet.
An acre is equal to a square, the side of which is 208.7 feet.

Dry Measure

1 bushel (U.S. or Winchester struck bushel) = 1.2445 cubic foot = 2150.42 cubic inches.
1 bushel = 4 pecks = 32 quarts = 64 pints.
1 peck = 8 quarts = 16 pints.
1 quart = 2 pints.
1 heaped bushel = 1-1/4 struck bushel.
1 cubic foot = 0.8036 struck bushel.
1 British Imperial bushel = 8 Imperial gallons = 1.2837 cubic foot = 2218.19 cubic inches.

Liquid Measure

1 U.S. gallon = 0.1337 cubic foot = 231 cubic inches = 4 quarts = 8 pints.
1 quart = 2 pints = 8 gills.
1 pint = 4 gills.
1 British Imperial gallon = 1.2003 U.S. gallon = 277.27 cubic inches.
1 cubic foot = 7.48 U.S. gallons.

Circular and Angular Measure

60 seconds(") = 1 minute (').
60 minutes = 1 degree (°).
360 degrees = 1 circumference (C).
57.3 degrees = 1 radian
2pie radians = 1 circumference.

Specific Gravity

The specific gravity of a substance is its weight as compared with the weight of an equal bulk of pure water.
For making specific gravity determinations the temperature of the water is usually taken at 62°F. when 1 cubic foot of water weighs 62.355 lbs. Water is at its greatest density at 39.2°F. or 4° Centigrade.

Temperature

The following equation will be found convenient for transforming temperature from one system to another:
Let F = degrees Fahrenheit; C = degrees Centigrade; R = degrees Reamur.

$$\frac{F-32}{180} = \frac{C}{100} = \frac{R}{80}$$

Avoirdupois or Commercial Weight

1 gross or long ton = 2240 pounds.
1 net or short ton = 2000 pounds.
1 pound = 16 ounces = 7000 grains.
1 ounce = 16 drams = 437.5 grains.

Measures of Pressure

1 pound per square inch = 144 pounds per square foot = 0.068 atmosphere = 2.042 inches of mercury at 62 degrees F. = 27.7 inches of water at 62 degrees F. = 2.31 feet of water at 62 degrees F.
1 atmosphere = 30 inches of mercury at 62 degrees F. = 14.7 pounds per square inch = 2116.3 pounds per square foot = 33.95 feet of water at 62 degrees F.

ENGLISH STANDARD MEASURES
(continue)

Measures of Pressure (continued)

1 foot of water at 62 degrees F. = 62.355 pounds per square foot = 0.433 pounds per square inch.

1 inch of mercury at 62 degrees F. = 1.132 foot of water = 13.58 inches of water = 0.491 pound per square

Column of water 12 in. high, 1 in. dia. = .341 lbs.

Cubic Measure

1 cubic yard = 27 cubic feet.

1 cubic foot = 1728 cubic inches.

The following measures are also used for wood and masonry:

1 cord of wood = 4 x 4 x 8 feet = 128 cubic feet.

1 perch of masonry = 16-1/2 x 1-1/2 x 1 foot = 24-3/4 cubic feet.

Shipping Measure

For measuring entire internal capacity of a vessel:

1 register ton = 100 cubic feet.

For measurement of cargo:

1 U.S. shipping ton = 40 cubic feet = 32.143 U.S. bushels = 31.16 Imperial bushels.

British shipping ton = 42 cubic feet = 33.75 U.S. bushels = 32.72 Imperial bushels.

Troy Weight
Used for Weighing Gold and Silver

1 pound = 12 ounces = 5760 grains.

1 ounce = 20 pennyweights = 480 grains.

1 pennyweight = 24 grains.

1 carat (used in weighing diamonds) = 3.086 grains.

1 grain Troy = 1 grain avoirdupois = 1 grain apothecaries' weight.

Measure Used for Diameters and Areas of Electric Wires

1 circular inch = area of circle 1 inch in diameter = 0.7854 square inch.

1 circular inch = 1,000,000 circular mils.

1 square inch = 1.2732 circular inch = 1,273,239 circular mils.

A circular mil is the area of a circle 0.001 inch in diameter.

Board Measure

One foot board measure is a piece of wood 12 inches square by 1 inch thick, or 144 cubic inches. 1 cubic foot therefore equals 12 feet board measure.

METRIC SYSTEM OF MEASUREMENTS

The principal units are the meter for length, the liter for capacity and the gram for weight. The following prefixes are used for sub-divisions and multiples: milli = 1/1000; centi = 1/100; deci = 1/10; deca = 10; hecto = 100; kilp = 1000.

Measure of Length

10 millimeters (mm)	= 1 centimeter (cm)
10 centimeters	= 1 decimeter (dm)
10 decimeters	= 1 meter (m)
1000 meters	= 1 kilometer (km)

Measures of Weight

10 milligrams (mg)	= 1 centigram (cg)
10 centigrams	= 1 decigram (dg)
10 decigrams	= 1 gram (g)
10 grams	= 1 decagram (Dg.)
10 decagrams	= 1 hectogram (Hg)
10 hectograms	= 1 kilogram (Kg)
1000 kilograms	= 1 (metric) ton (T)

Surveyor's Square Measure

100 square meters (m^2)	= 1 are (ar)
100 ares	= 1 hectare (har)
100 hectares	= 1 sq. kilometer (Km^2)

Square Measure

100 sq millimeters (mm^2)	= 1 sq centimeter cm^2)
100 sq centimeters	= 1 sq decimeter (dm^2)
100 sq decimeters	= 1 sq meter (m^2)

Cubic Measure

1000 cu millimeters (mm^3)	= 1 cu centimeter (cm^3)
1000 cu centimeters	= 1 cu decimeter (dm^3)
1000 cu decimeters	= 1 cu meter (m^3)

Dry and Liquid Measure

10 milliliters (ml)	= 1 centiliter (cl)
10 centiliters	= 1 deciliter (dl)
10 deciliters	= 1 liter (l)
100 liters	= 1 hectoliter (Hi)

1 liter = 1 cubic decimeter = the volume of 1 kilogram of pure water at a temperature of 39.2 degrees F.

Length Conversion Constants for Metric and U.S. Units

Millimeters x .039370 = inches.
Meters x 39.370 = inches.
Meters x 3.2808 = feet.
Meters x 1.09361 = yards.
Kilometers x 3,280.8 = feet.
Kilometers x .62137 = Statute Miles.
Kilometers x .53959 = Nautical Miles.

Inches x 25.4 = millimeters.
Inches x .02540 = meters.
Feet x .30480 = meters.
Yards x .91440 = meters.
Feet x .0003048 = kilometers.
Statute Miles x 1.60935 = kilometers.
Nautical Miles x 1.85325 = kilometers.

Weight Conversion Constants for Metric and U.S. Units

Grams x 981 = dynes.
Grams x 15.432 = grains.
Grams x .03527 = ounces (Avd.).
Grams x .033818 = fluid ounces (water).
Kilograms x 35.27 = ounces (Avd.).
Kilograms x 2.20462 = pounds (Avd.).
Metric Tons (1000 Kg.) x 1.10231 = Net Tons (2000 lbs.).
Metric Tons (1000 Kg.) x .98421 = Gross Ton (2240 lbs.).

Dynes x .0010193 = grams.
Grains x .0648 = grams.
Ounces (Avd.) x 28.35 = grams.
Fluid Ounces (Water) x 29.57 = grams.
Ounces (Avd.) x .02835 = kilograms.
Pounds (Avd.) x .45359 = kilograms.
Net Ton (2000 lbs.) x .90719 = Metric Ton (1000 Kg.).
Gross Ton (2240 lbs.) x 1.01605 = Metric Tons (1000 Kg.).

METRIC SYSTEM OF MEASUREMENTS
(continued)

Area Conversion Constants for Metric and U.S. Units

Square Millimeters x .00155 = square inches.
Square Centimeters x .155 = square inches.
Square Meters x 10.76387 = square feet.
Square Meters x 1.19599 = square yards.
Hectares x 2.47105 = acres.
Square Kilometers x 247.105 = acres.
Square Kilometers x .3861 = square miles.

Square Inches x 645.163 = square millimeters.
Square Inches x 6.45163 = square centimeters.
Square Feet x .0929 = square meters.
Square Yards x .83613 = square meters.
Acres x .40469 = hectares.
Acres x .0040469 = square kilometers.
Square Miles x 2.5899 = square kilometers.

Volume Conversion Constants for Metric and U.S. Units

Cubic Centimeters x .033818 = fluid ounces.
Cubic Centimeters x .061023 = cubic inches.
Cubic Centimeters x .271 = fluid drams.
Liters x 61.023 = cubic inches.
Liters x 1.05668 = quarts.
Liters x .26417 = gallons.
Liters x .035317 = cubic feet.
Hectoliters x 26.417 = gallons.
Hectoliters x 3.5317 = cubic feet.
Hectoliters x 2.83794 = bushel (2150.42 cu. ft.).
Hectoliters x .1308 = cubic yards.
Cubic Meters x 264.17 = gallons.
Cubic Meters x 35.317 = cubic feet.
Cubic Meters x 1.308 = cubic yards.

Fluid Ounces x 29.57 = cubic centimeters.
Cubic Inches x 16.387 = cubic centimeters.
Fluid Drams x 3.69 = cubic centimeters.
Cubic Inches x .016387 = liters.
Quarts x .94636 = liters.
Gallons x 3.78543 = liters.
Cubic Feet x 28.316 = liters.
Gallons x .0378543 = hectoliters.
Cubic Feet x .28316 = hectoliters.
Bushels (2150.42 cu. in.) x .352379 = hectoliters.
Cubic Yards x 7.645 = hectoliters.
Gallons x .00378543 = cubic meters.
Cubic Feet x .028316 = cubic meters.
Cubic Yards x .7645 = cubic meters.

Power and Heat Conversion Constants for Metric and U.S. Units

Calorie x 0.003968 = B.T.U.
Joules x .7373 = foot pounds.
Kilogrammeters x 7.233 = foot pounds.
Cheval Vapeur x .9863 = Horsepower.
Kilowatts x 1.34 = Horsepower.
Kilowatt Hours x 3415 = B.T.U.
(Degrees Cent. x 1.8) + 32 = degrees Fahr.
(Degrees Reamur x 2.25) + 32 = degrees Fahr.

B.T.U. x 252 = calories.
Foot Pounds x 1.3563 = joules.
Foot Pounds x .13825 = kilogrammeters.
Horsepower x 1.014 = Cheval Vapeur.
Horsepower x .746 = kilowatts.
B.T.U. x .00029282 = kilowatt hours.
(Degrees Fahr. - 32) x .555 = degrees Cent.
(Degrees Fahr. - 32) x .444 = degrees Reamur.

INCH - MILLIMETER EQUIVALENTS

Inches		Milli-meters	Inches		Milli-meters	Inches		Milli-meters
Fractions	Decimals		Fractions	Decimals		Fractions	Decimals	
	.00394	.1	3/32	.09375	2.3812	3/16	.1875	4.7625
	.00787	.2		.09449	2.4		.18898	4.8
	.01	.254		.09843	2.5		.19	4.826
	.01181	.3		.1	2.54		.19291	4.9
				.10236	2.6		.19685	5.0
				.10630	2.7		.2	5.08
							.20079	5.1
1/64	.015625	.3969	7/64	.109375	2.7781	13/64	.203125	5.1594
	.01575	.4		.11	2.794		.20472	5.2
	.01969	.5		.11024	2.8		.20866	5.3
	.02	.508		.11417	2.9		.21	5.334
	.02362	.6		.11811	3.0		.21260	5.4
	.02756	.7		.12	3.048		.21654	5.5
	.03	.762		.12205	3.1			
1/32	.03125	.7938	1/8	.125	3.175	7/32	.21875	5.562
	.0315	.8		.12598	3.2		.22	5.588
	.03543	.9		.12992	3.3		.22047	5.6
	.03937	1.0		.13	3.302		.22441	5.7
	.04	1.016		.13386	3.4		.22835	5.7
	.04331	1.1		.13780	3.5		.23	5.842
				.14	3.556		.23228	5.9
3/64	.046875	1.1906	9/64	.140625	3.5719	15/64	.234375	5.9531
	.04724	1.2		.14173	3.6		.23622	6.0
	.05	1.27		.14567	3.7		.24	6.096
	.05118	1.3		.14961	3.8		.24016	6.1
	.05512	1.4		.15	3.810		.24409	6.2
	.05906	1.5		.15354	3.9		.24803	6.3
	.06	1.524						
1/16	.0625	1.5875	5/32	.15625	3.9688	1/4	.25	6.35
	.06299	1.6		.15748	4.0		.25197	6.4
	.06693	1.7		.16	4.064		.25591	6.5
	.07	1.778		.16142	4.1		.25984	6.6
	.07087	1.8		.16535	4.2		.26	6.604
	.07480	1.9		.16929	4.3		.26378	6.7
				.17	4.318			
5/64	.078125	1.9844	11/64	.171875	4.3656	17/64	.265625	6.7469
	.07874	2.0		.17323	4.4		.26772	6.8
	.08	2.032		.17717	4.5		.27	6.858
	.08268	2.1		.18	4.572		.27165	6.9
	.08661	2.2		.18110	4.6		.27559	7.0
	.09	2.286		.18504	4.7		.27953	7.1
	.09055	2.3					.28	7.112

INCH - MILLIMETER EQUIVALENTS

(continue)

Inches		Milli- meters	Inches		Milli- meters	Inches		Milli- meters
Fractions	Decimals		Fractions	Decimals		Fractions	Decimals	
9/32	.28125	7.1438	3/8	.375	9.525	15/32	.46875	11.9062
	.28346	7.2		.33795	9.6		.47	11.938
	.28740	7.3		.38	9.652		.47244	12.0
	.29	7.366		.38189	9.7		.47638	12.1
	.29134	7.4		.38583	9.8		.48	12.192
	.29528	7.5		.38976	9.9		.48031	12.2
				.39	9.906		.48425	12.3
19/64	.296875	7.5406	25/64	.390625	9.9219	31/64	.484375	12.3031
	.29921	7.6		.39370	10.0		.48819	12.4
	.30	7.62		.39764	10.1		.49	12.446
	.30315	7.7		.40	10.16		.49213	12.5
	.30709	7.8		.40157	10.2		.49606	12.6
	.31	7.874		.40551	10.3			
	.31102	7.9						
5/16	.3125	7.9375	13/32	.40625	10.3188	1/2	.50	12.7
	.31496	8.0		.40945	10.4		.50394	12.8
	.31890	8.1		.41	10.414		.50787	12.9
	.32	8.128		.41339	10.5		.51	12.954
	.32283	8.2		.41732	10.6		.51181	13.0
	.32677	8.3		.42	10.688			
				.42126	10.7			
21/64	.328125	8.3344	27/64	.421875	10.7156	33/64	.515625	13.0969
	.33	8.382		.42520	10.8		.51575	13.1
	.33071	8.4		.42913	10.9		.51968	13.2
	.33465	8.5		.43	10.922		.52	13.208
	.33858	8.6		.43307	11.0		.52362	13.3
	.34	8.636		.43701	11.1		.52756	13.4
	.34252	8.7					.53	13.462
11/32	.34375	8.7312	7/16	.4375	11.1125	17/32	.53125	13.4938
	.34646	8.8		.44	11.176		.53150	13.5
	.35	8.89		.44094	11.2		.53543	13.6
	.35039	8.9		.44488	11.3		.53937	13.7
	.35433	9.0		.44882	11.4		.54	13.716
	.35827	9.1		.45	11.430		.54331	13.8
				.45276	11.5			
23/64	.359375	9.1281	29/64	.453125	11.5094	35/64	.546875	13.8906
	.36	9.144		.45669	11.6		.54724	13.9
	.36220	9.2		.46	11.684		.55	13.970
	.36614	9.3		.46063	11.7		.55118	14.0
	.37	9.398		.46457	11.8		.55512	14.1
	.37008	9.4		.46850	11.9		.55905	14.2
	.37402	9.5					.56	14.224

INCH - MILLIMETER EQUIVALENTS
(continue)

Inches		Milli-	Inches		Milli-	Inches		Milli-
Fractions	Decimals	meters	Fractions	Decimals	meters	Fractions	Decimals	meters
9/16	.5625	14.2875	21/32	.65625	16.6688	3/4	.75	19.050
	.56299	14.3		.65748	16.3		.75197	19.1
	.56693	14.4		.66	16.4		.75590	19.2
	.57	14.478		.66142	16.5		.75984	19.3
	.57087	14.5		.65	16.510		.76	19.304
	.57480	14.6		.65354	16.6		.76376	19.4
				.67	17.018			
37/64	.578125	14.6844	43/64	.671875	17.0656	49/64	.765625	19.4469
	.57874	14.7		.67323	17.1		.76772	19.5
	.58	14.732		.67716	17.2		.77	19.558
	.58268	14.8		.68	17.272		.77165	19.6
	.58661	14.9		.68110	17.3		.77559	19.7
	.59	14.986		.68504	17.4		.77953	19.8
	.59055	15.0					.78	19.812
19/32	.59375	15.0812	11/16	.6875	17.4625	25/32	.78125	19.8438
	.59449	15.1		.68898	17.5		.78346	19.9
	.59842	15.2		.69	17.526		.78740	20.0
	.60	15.24		.69291	17.6		.79	20.066
	.60236	15.3		.69685	17.7		.79134	20.1
	.60630	15.4		.70	17.78		.79527	20.2
				.70079	17.8			
39/64	.609375	15.4781	45/64	.703125	17.8594	51/64	.796875	20.2406
	.61	15.494		.70472	17.9		.79921	20.03
	.61024	15.5		.70866	18.0		.80	20.320
	.61417	15.6		.71	18.034		.80315	20.4
	.61811	15.7		.71260	18.1		.80709	20.5
	.62	15.748		.71653	18.2		.81	20.574
	.62205	15.8					.81102	20.6
5/8	.625	15.875	23/32	.71875	18.2562	13/16	.8125	20.6375
	.62598	15.9		.72	18.288		.81496	20.7
	.62992	16.0		.72047	18.3		.81890	20.8
	.63	16.002		.72441	18.4		.82	20.828
	.63386	16.1		.72835	18.5		.82283	20.9
	.63779	16.2		.73	18.542		.82677	21.0
	.64	16.256		.73228	18.6			
41/64	.640625	16.2719	47/64	.734375	18.6531	53/64	.828125	21.0344
	.64173	16.3		.73622	18.7		.83	21.082
	.64567	16.4		.74	18.796		.83071	21.1
	.64961	16.5		.74016	18.8		.83464	21.2
	.65	16.510		.74409	18.9		.83858	21.3
	.65354	16.6		.74803	19.0		.84	21.336
							.84252	24.4

INCH - MILLIMETER EQUIVALENTS

(continue)

Inches		Milli- meters	Inches		Milli- meters	Inches		Milli- meters
Fractions	Decimals		Fractions	Decimals		Fractions	Decimals	
27/32	.84375	21.4312	29/32	.90625	23.0188	31/32	.96875	24.6062
	.84646	21.5		.90945	23.1		.97	24.638
	.85	21.590		.91	23.114		.97244	24.7
	.85039	21.6		.91338	23.2		.97638	24.8
	.85433	21.7		.91732	23.3		.98	24.892
	.85827	21.8		.92	23.368		.98031	24.9
				.92126	23.4		.98425	25.0
55/64	.859375	21.8281	59/64	.921875	23.4156	63/64	.984375	25.0031
	.86	21.844		.92520	23.5		.98819	25.1
	.86220	21.9		.92913	23.6		.99	25.146
	.86614	22.0		.93	23.622		.99212	25.2
	.87	22.098		.93307	23.7		.99606	25.3
	.87008	22.1		.93701	23.8			
	.87401	22.2						
7/8	.875	22.225	15/16	.9375	23.8125	1	1.0000	25.400
	.87795	22.3		.94	23.876	1-1/4	1.25	31.750
	.88	22.352		.94094	23.9	1-1/2	1.5	38.100
	.88189	22.4		.94488	24.0	1-3/4	1.75	44.450
	.88583	22.5		.94882	24.1	2	2.0000	50.800
	.88976	22.6		.95	24.130	2-1/2	2.5	63.500
	.89	22.606		.95275	24.2	3	3.0000	76.200
						3-1/2	3.5	88.000
						4	4.0000	101.600
						4-1/2	4.5	144.300
						5	5.0000	127.000
						6	6.0000	152.400
						7	7.0000	177.800
						8	8.0000	203.200
						9	9.0000	228.600
						10	10.0000	254.000